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J. A. COOK & SON LIMITED STATIONERS 77 BAY ST. TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

ONTREAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 1103 Union Trust Building

ol. XIV. No. 19. Publication Office, Toronto—January 5, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

THE COLE

DIRECT-RETURN

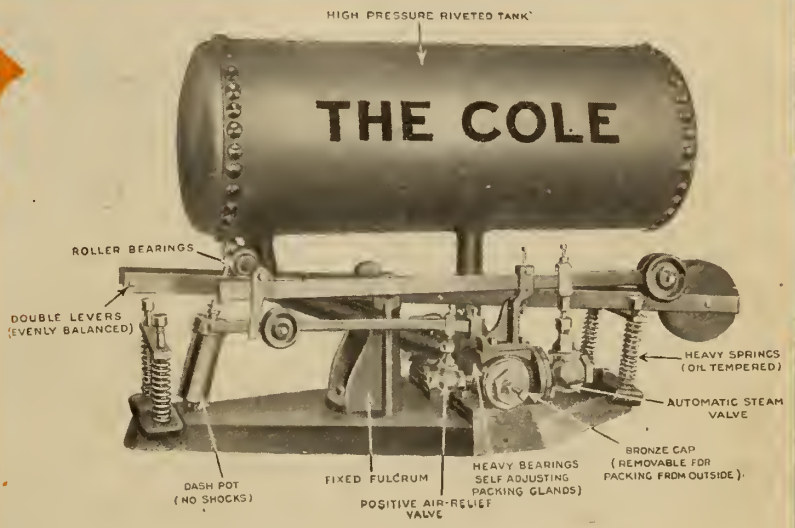
STEAM TRAP

for

LESS FUEL

and

MORE HEAT



ANY plant or building using steam should have Cole Equipment. It will save you money. Every year **Cole Steam Traps** are saving thousands of dollars in fuel for their users.

In any plant—no matter what the conditions are—**The Cole System** will deal effectively with condensation, returning it directly to the boiler, thus eliminating waste, and, as a result, effecting a large saving in fuel.

When buying be sure to specify **The Cole.** Our experience in Condensation Engineering extends over twenty years.

May one of our Engineers visit your plant, and study your problems? All applications of **The Cole System** are made with special reference to conditions which exist in each plant, for which the system is specified, hence success in every case.

Interesting literature upon request.

GEO. W. COLE LIMITED

Engineers and Manufacturers

2002-4 Dundas St. W., TORONTO, Canada

510 Coristine Bldg., Montreal, Que. Winnipeg, Man. Vancouver, B.C. New Glasgow, N.S.

Even in Far Japan C-P Compressors are daily demonstrating their Success Qualities. These 3 Class O-CE units in the power plant of the Yokohama Dock Company, Yokohama, Japan, deliver 5,190 cubic feet of air per minute.

Success Qualities

SUCCESS QUALITIES that make good men make good air compressors. These qualities stand up under "hard knocks," stay on the job when they're needed, and *wear well* as the years speed on.

The *success qualities* of Chicago Pneumatic Air Compressors are these features, embodied in over three hundred sizes and types:

Simplate flat-disc indestructible valves, exceptionally large bearing surfaces, totally enclosed frame construction—

—automatic lubrication throughout, automatic regulation (insuring high operating economy under variable loads)—

—and unyielding, sturdy construction throughout, capable of withstanding *any* service condition.

Ask for Bulletins.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C 60 H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES — ROCK DRILLS · · COAL DRILLS

CANADIAN CP PNEUMATIC

CHICAGO PNEUMATIC

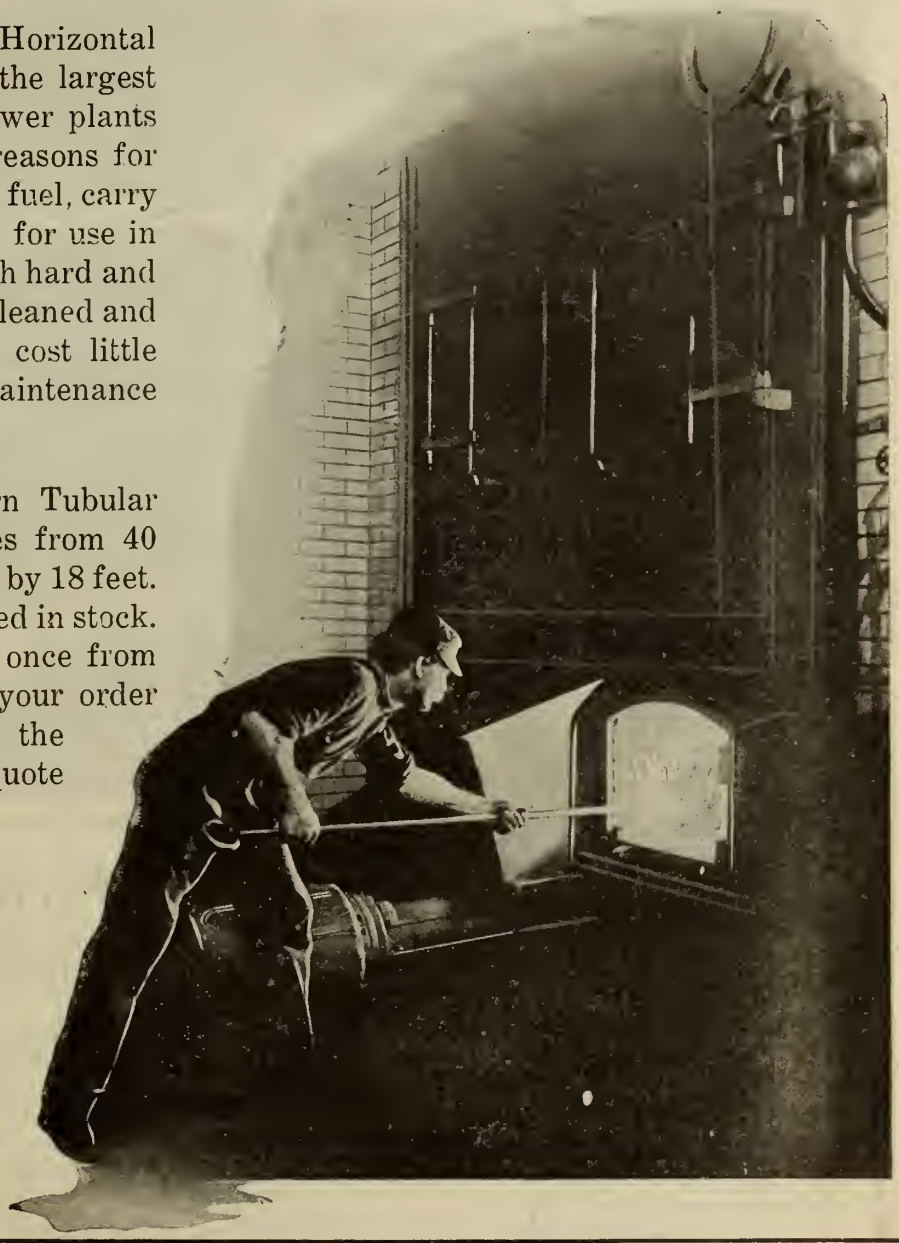
The Compressor with the Simplate Valve

BOILERS

FOR POWER AND HEATING PURPOSES

You will find Waterous Horizontal Return Tabular Boilers in the largest industrial and municipal power plants in the country. There are reasons for this. They are economical of fuel, carry a big reserve steam pressure for use in emergencies, can be used with hard and dirty water, and are readily cleaned and easily taken care of. They cost little new; their upkeep and maintenance expense is negligible.

Waterous Horizontal Return Tubular Boilers are built in all sizes from 40 inches by 10 feet to 72 inches by 18 feet. Most standard sizes are carried in stock. If we cannot supply you at once from our yards we can turn out your order for you in quick time. On the next boiler you need let us quote you prices and delivery.



Boilers in Stock

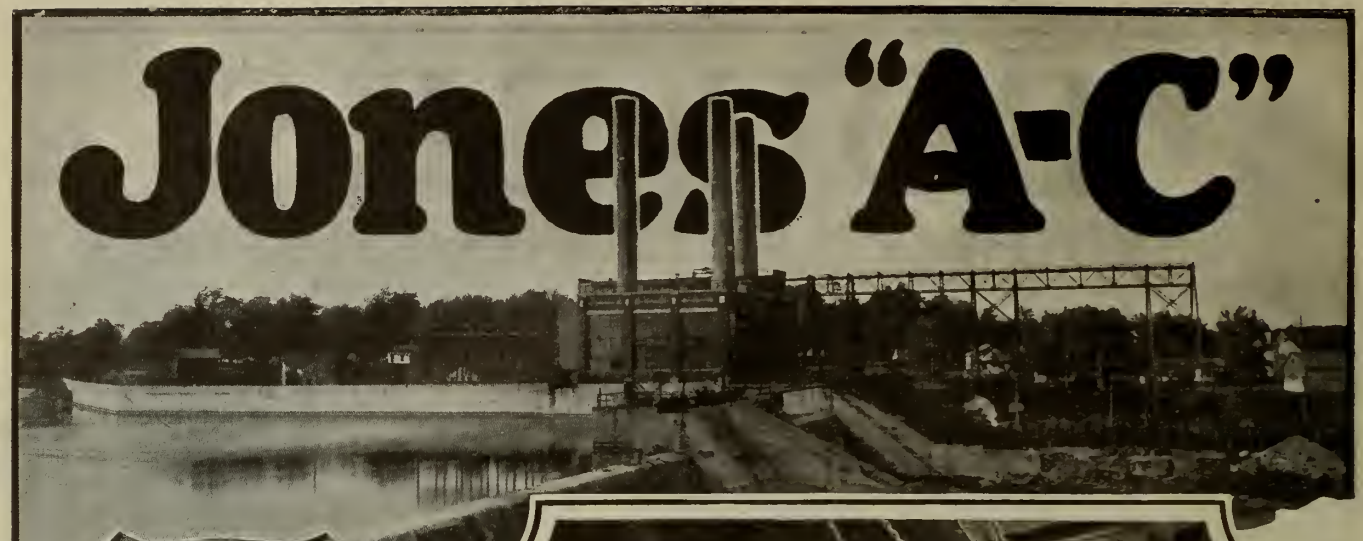
7—66 x 16 Horizontal
3—72 x 16 "
8—72 x 18 "
6—30 H.P. Locomotive
5—40 H.P. "
6—60 H.P. "
2—No. 20 Kewanee Type Heating Boilers

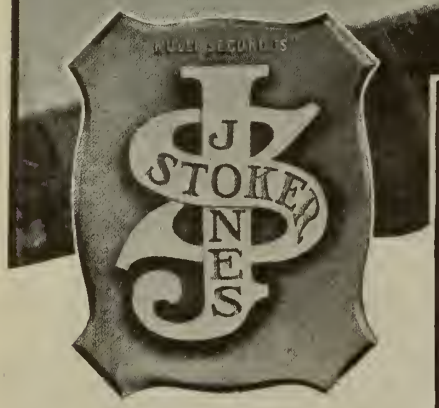
Waterous

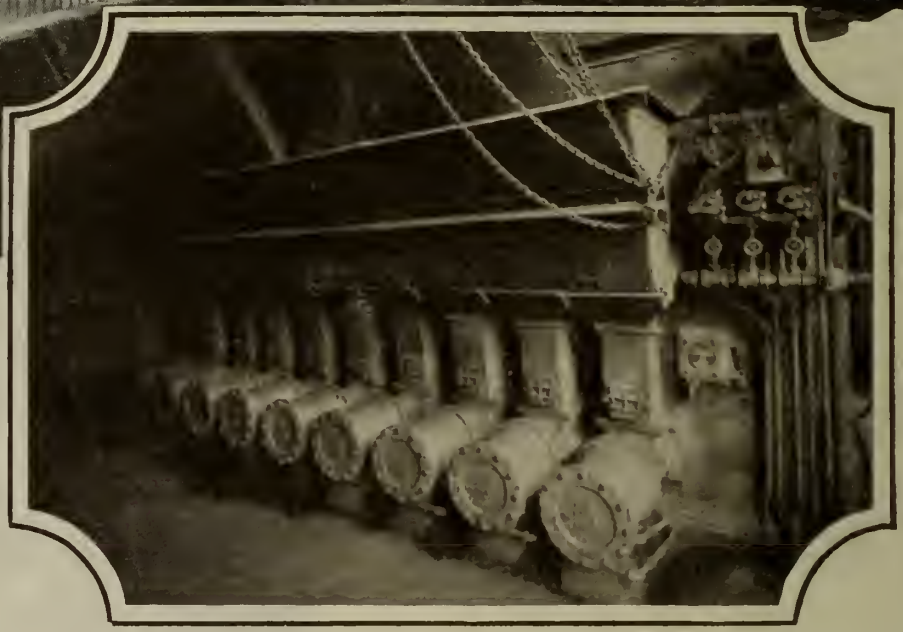
BRANTFORD, ONTARIO, CANADA

POWER HOUSE, January 5, 1921. Vol. XIV, No. 1. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

Jones "A-C"







Jones "A-C" Stokers used in connection with Hydro-Electric Development. The same stoker that is giving excellent results in large plants is also ideal for small plants. The saving is even more gratifying.

Since Hand Firing Won't Do . . . Install a Real High-Duty Stoker

TOO many stokers are merely substitutes for hand firing. By eliminating the waste of hand firing they effect economy—but not as great economy as is possible through real high-duty stoker firing. Small plants as well as large plants, to-day regard a stoker as a means of economy instead of an expense. First cost is considered only in relation to the dividend it yields.

The Jones "A-C" has proved its ability as a dividend producer by perfectly fulfilling the rigid requirements of high-duty stoking.

Its extreme simplicity—only one moving part, none in the fire—reduces maintenance and practically eliminates shut-downs.

The under-feed principle of combustion a principle originated in Jones stoker provides maximum combustion efficiency, ability to burn poor grades of coal, and heavy overload capacity.

The automatic-cleaning feature and special tuyere construction overcome objectionable formation of clinkers on front, side, and bridge walls.

Automatic control of fuel and air insures even steam pressure under widely varying load demands.

What single investment will yield as great return as high duty stoker firing?

The new Jones "A-C" Catalog explains this new coal and labor saver in detail. Ask for a copy.

THE UNDER-FEED STOKER CO. OF CANADA, LIMITED

81 VICTORIA STREET - TORONTO

Made in Canada for Canadians

The Jones "A-C" is 100% Canadian—made in Canada by Canadians, and sold for Canadian money at par. The former Jones Under-Feed Stoker Company, Ltd., an organization commanding great respect in Canada, has recently been replaced by the Under-Feed Stoker Company of Canada, Ltd. To the vast experience of the older company is added the engineering resources of the Under-Feed Stoker Company of America. This unrivalled engineering combination is at your command. Investigate.

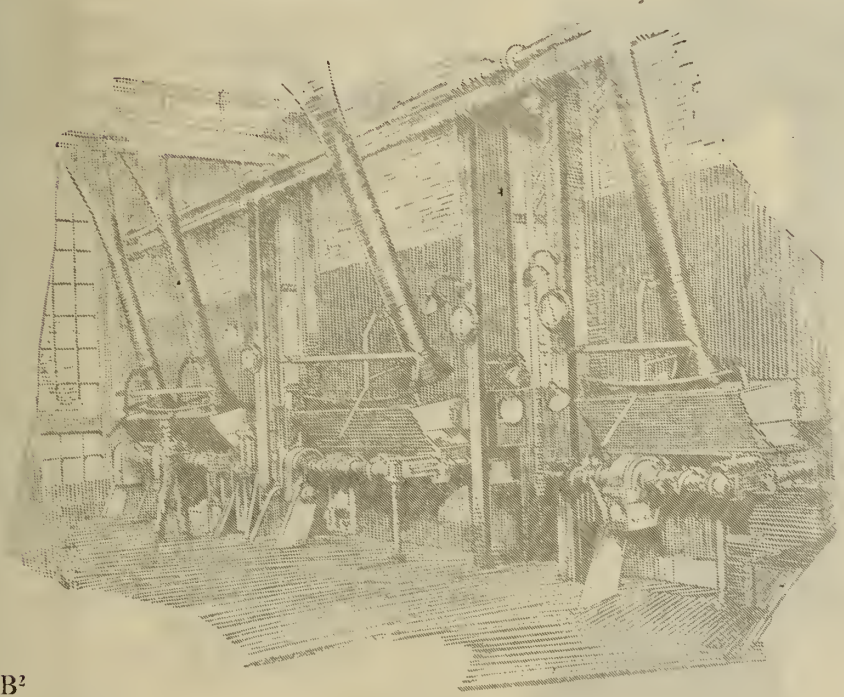
High-Duty Stoker

Worthington satisfies every power plant pumping need

IMMENSE shop facilities, standardized manufacturing plus over 81 years of designing, improving and manufacturing pumps and pumping machinery have resulted in apparatus of suitable design for every power plant pumping duty.

This broad range and varied choice of apparatus together with over 200,000,000 boiler horse power successfully satisfied since 1840 justifies specifying Worthington for power plant apparatus. The Worthington engineering corps always stand ready to co-operate in order to obtain greatest possible results from apparatus selected.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities



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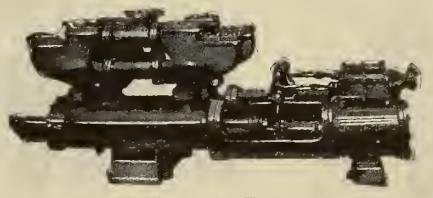
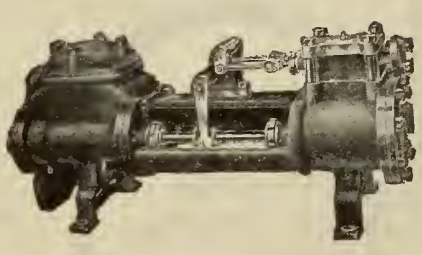
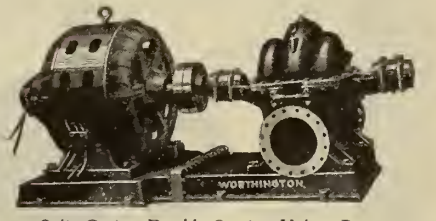


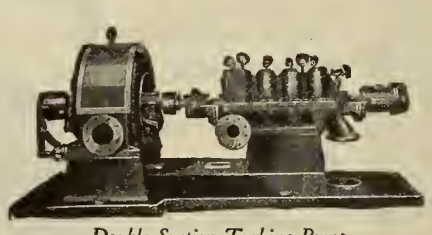
Pot Valve Boiler Feed Pump



Duplex Packed Piston Pump



Split Casing Double Suction Volute Pump



Double Suction Turbine Pump, Boiler Feed Pattern

Because of hot water pumping, centrifugal pumps become steam bound. Worthington double suction centrifugal boiler feeder is equipped with a floating sealing ring device which prevents seizing at close clearance points between rotor and casing.

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*

LUNKENHEIMER PRODUCTS

Globe Valves
Angle Valves
Gross Valves
Safety Non-return Stop Valves
Balanced Throttle Valves
Gate Valves
Check Valves
Blow-off Valves
Pop Safety and Relief Valves
Water Columns, Water Gauges and Gauge Cocks
Whistles and Whistle Valves
Ground Key Cocks
Injectors, Ejectors
Lubricators, Oil and Grease Cups
Oiling Devices
Automotive Accessories
Etc.

With more than fifty-eight years of success in service have established their reputation for quality. And "Lunkenheimer Quality" means reliability, continuity of service and economy in maintenance.

The Lunkenheimer system of test and inspection gives a perfect knowledge of the condition and actual performance of the article before it leaves the factory; proves its serviceability, and assures the user safe and efficient operation.

Write "Lunkenheimer-Equipped" in your Engine and Boiler specifications. It is a guarantee for Safety, Efficiency, Permanence and Satisfaction.

Lunkenheimer Products are obtainable from supply houses everywhere. Insist on having the genuine.

THE LUNKENHEIMER CO.
—"QUALITY"—

Largest Manufacturers of
High Grade Engineering Specialties
in the World
CINCINNATI, O., U.S.A.

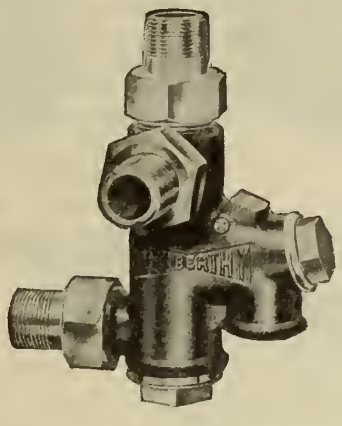
New York Chicago
Boston London

Export Department:
129-135 Lafayette St.,
New York, N.Y.

TRADE

PENBERTHY

MARK.



STANDARD OF THE WORLD!

On November 10th, 1918

The One Millionth

Penberthy Injector was completed and tested in the Penberthy shops and passed on its way to give the same efficient and satisfactory service that the other 999,999 that preceded it have given throughout the world.

What made this millionth Injector possible?

The Reputation for Reliability

That same trade mark is now associated with the highest grade line of brass valves on the market to-day. They are all designed with the "Outside bonnet construction," the first radical improvement made in brass valves in generations. They are made of the best quality of virgin metal, modern in design and of the best workmanship and finish. To get the most efficient and economical service

Let your next order for valves read "Penberthy"

PENBERTHY INJECTOR CO. LIMITED
WINDSOR CANADA

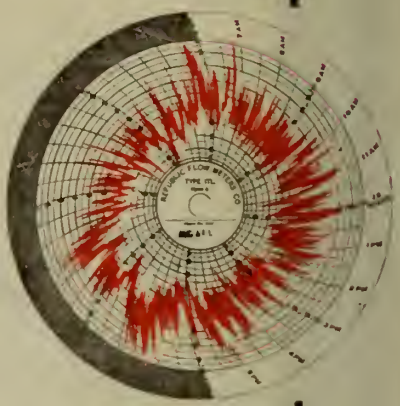
THE MASON TRADE-MARK

"SERVICE"

The charts on this page are from the plant of one of the largest Rubber Factories in Canada. In one of their processes it is absolutely necessary that steam be delivered at an even pressure, regardless of boiler pressure and the amount of steam used. The Mason Reducing Valve has been chosen to do this important service, as absolute reliability is essential—any variation of pressure, and therefore of temperature, meaning the loss of a day's production.

FIRST—THE BOILER PRESSURE

Fluctuating between
140 lbs. and 170 lbs.



SECOND—THE STEAM FLOW

Ranging from 100%, or full load
to only 10% of capacity.

THEN—A GENUINE MASON REDUCING VALVE

FINALLY—THE RESULT

an absolutely even pressure
—day and night—never varying a fraction of a pound.

ARE YOU CONCERNED WITH RESULTS?

BE SURE OF THE MASON TRADE-MARK ON ALL YOUR REGULATING APPLIANCES

The Mason Regulator & Engineering Company, Limited

MONTREAL
135-153 DAGENAIS ST. (ST. HENRY)

TORONTO
145 WELLINGTON STREET WEST

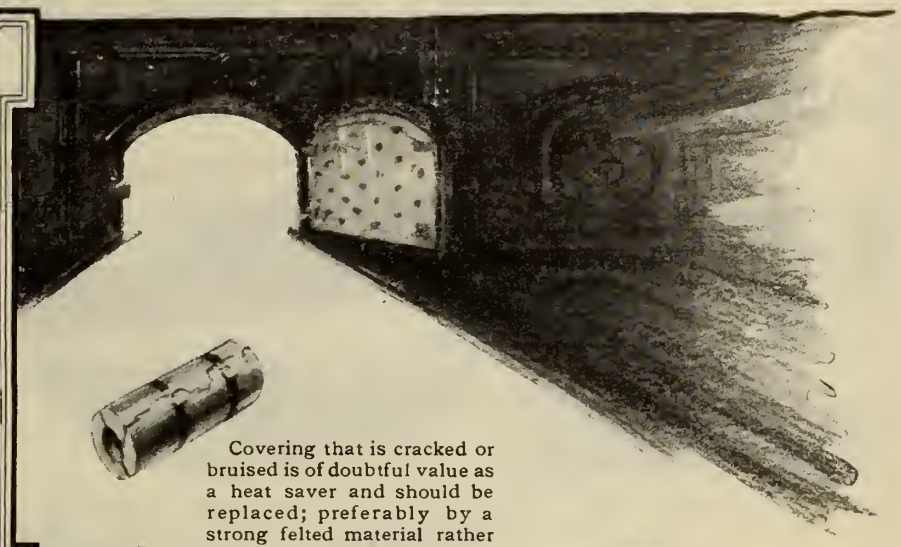
MASON STANDARD REDUCING VALVES ARE MADE IN CANADA

Six ways to tell how your heat is wasted

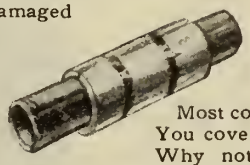
TO encourage fuel Saving we have thought it helpful to show some of the ways that heat is lost or wasted and how such losses can be located.

The common causes for heat loss are not deeply hidden. On the contrary, they are evident to anyone who will look for them.

If you find any one of the conditions below in your system, you can without a doubt be helped by Johns-Manville Insulation Service.

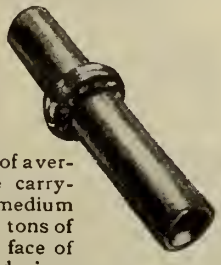


Covering that is cracked or bruised is of doubtful value as a heat saver and should be replaced; preferably by a strong felted material rather than the more easily damaged molded kind.

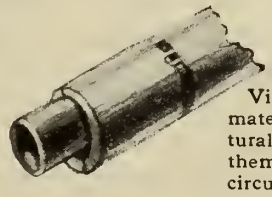


Most coverings are too thin. You cover pipes to save heat. Why not save all that is possible by using proper thickness—instead of accepting the partial saving of thin inadequate materials.

Often, pipes are covered but flanges and fittings left bare. Very wasteful. More fuel is wasted by leaving one pair of flanges bare than if a whole foot of the pipe itself were left uncovered.



Twenty-five feet of average size bare pipe carrying steam at a medium pressure wastes 14 tons of coal a year. In the face of this fact uncovered pipes are inexcusable.



Vibration wears away materials that are structurally weak causing them to sag, allowing circulation of air between covering and pipe, thus reducing their effective thickness and insulating value. Moral: Be sure that the material you use has more than heat-saving value—that it has long life as well—preferably a *felted* rather than a *molded* material.

Not only pipes but every hot surface must be insulated to secure maximum fuel savings. Don't be content with saving heat loss from pipes alone—find every hot surface and have it properly insulated.

JOHNS-MANVILLE SERVICE COVERS THIS CONTINENT

Through—

Asbestos

and its allied products

INSULATION *that keeps the heat where it belongs*
CEMENTS *that make boiler walls leak proof*
ROOFINGS *that cut down fire risks*
PACKINGS *that save power waste*
LININGS *that make brakes safe*
FIRE PREVENTION PRODUCTS

CANADIAN JOHNS-MANVILLE CO. LIMITED
Toronto, Montreal, Winnipeg, Vancouver, London, Hamilton, Ottawa, Windsor

JOHNS-MANVILLE
Serves in Conservation

Asbestocel

For hot water and low pressure steam lines. Note that the corrugations run around the pipe, not along its length. This effects a marked increase in efficiency.

Asbesto-Sponge Felt

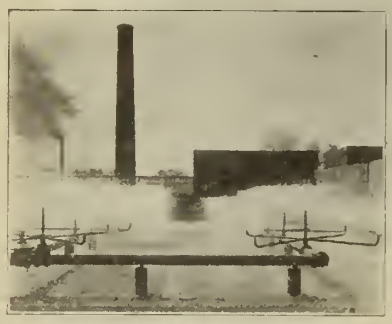
The most efficient commercial insulation known, and the most durable, because felted instead of molded, hence most economical.

85% Magnesia

Johns-Manville 85% Magnesia, the most durable and efficient insulation of the molded type.

"SPRA-RITE"

Cooling Systems for Cooling Condenser Water



Iowa Railway & Light Co., Marshalltown.

Central Illinois Public Service Co., Harrisburg, Ill. Capacity 10,000 G.P.M.

Whitman & Barnes Mfg. Co., West Pullman, Ill.

"SPRA-RITE" The Modern Way

THE "SPRA-RITE" System is the modern means of water cooling where the plant is not within easy reach of natural bodies of water. This up-to-date method consists of Spray Cooling Ponds for cooling the condenser water so that the available supply can be used over and over again. The "SPRA-RITE" system meets every requirement in the shape of capacity, flexibility, and cooling efficiency. Spray ponds can be in any shape, depending upon the space available. Concrete ponds are extensively used; this is conceded to be the best practice. Natural ponds and specially constructed earthen basins may also be used with success. If ground space is limited a building roof may be utilized. We furnish plans and recommendation for any kind of installation.

SPRA-RITE Two-Vane Nozzle. Its function is to discharge fine spray of equal density throughout their entire cross section.

Its Benefits are Manifold

THE largest power and industrial plants of this and other countries are adopting Spray Cooling Ponds equipped with our well-known SPRA-RITE Nozzles and Cluster Fittings. Besides giving remarkable cooling capacity they frequently serve to reduce insurance rates as there is always ample water supply close at hand for use by fire pumps.

For Steam Condensing equipment SPRA-RITE Cooling Systems represent the highest standard of efficiency, but a spray cooling system will show its highest efficiency only when equipped with SPRA-RITE Nozzles, which were primarily designed for this application.

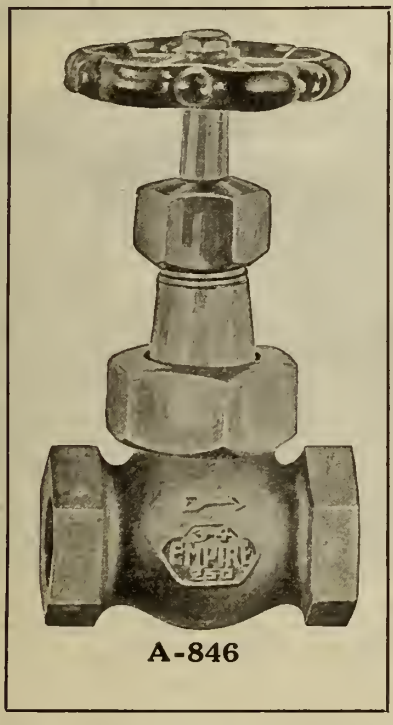
SPRA-RITE Cooling Systems have proved their efficiency for ice plant service. They are now considered standard equipment by refrigerating engineers and ice plant operators.

Let us have your inquiries regarding the cooling of water.

THE ARTHUR S. LEITCH CO., LIMITED

1001-2 KENT BUILDING **TORONTO, ONTARIO**

Works at High Pressure



A-846

THIS EMPIRE re-grinding valve is designed for use in connection with high-pressure steam and marine work. It is made of high-grade steam metal and is factory-tested and fully guaranteed for working pressures up to 250 pounds.

It is doubly serviceable because the seat can easily be re-ground from time to time.

You can confidently recommend it for any high-pressure steam work.

We make and supply all kinds of valves—one for every need, also plumbing supplies and sanitary fixtures of every description. Handled by leading jobbers throughout Canada. Write us.

"If it's an EMPIRE product you know it's right."

Empire Brass Mfg. Co., Limited

London and Toronto, Canada

LINDE

Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

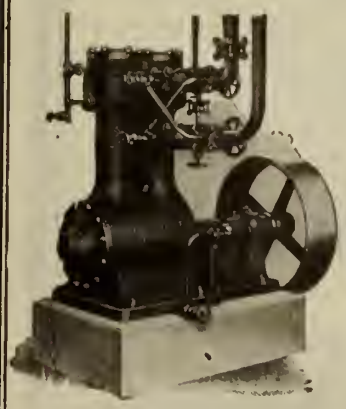
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Two Degrees in Sixteen Hours

The single white line on this thermometer chart tells a more remarkable story than many lines of written words. The chart was taken in a pair of hardening rooms containing 3,000 gallons of cream in the plant of the American Ice Cream Co., Augusta, Ga., on July 21st and 22nd, 1920. At 8 P.M., the valve was closed and the machine shut down. At 3 A.M. and again at 8 A.M., employees entered the room to remove cream. At 12 noon, the room was opened, most of the cream removed, fresh cream put in and refrigeration again turned on.

Follow the line carefully and note that the two little jogs, when the room was opened, account for practically the total rise in temperature of **only two degrees in sixteen hours**, with the machine shut down. Remarkable as it is, this is not exceptional. It is typical of charts turned in daily at this plant.

Nothing but good design and **the best of insulation** make such records possible. In this case, eight inches of Nonpareil Corkboard on walls, floor and ceiling, stand between inside zero and outside summer so effectually that no refrigeration is required to hold a practically constant temperature for many hours. Such efficiency means profits on the balance sheet and dollars in the bank.

How to insulate for such results is explained in the 152-page book, "Nonpareil Corkboard Insulation"—thickness to use—how to erect it—complete information, fully detailed. There is no charge. Send for your copy.

ARMSTRONG CORK AND INSULATION CO., LTD.

902 McGill Building
MONTREAL, QUE.

11 Church Street
TORONTO, ONT.

NONPAREIL CORKBOARD INSULATION

For All Cold Storage Rooms

QUALITY YORK SERVICE

York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

The Uniflow Steam Engine presents itself as the best solution of this difficulty

York Mfg. Co., York, Pa.

Canadian Representative:

Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St.
CALGARY: 605 Second St.

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New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

The best bearing metal may come to grief through mechanical defects, which no babbitt could withstand, or by reason of faulty lubrication, as a grease that is too heavy for a light-running bearing, or an oil too thin for a heavy bearing, will invariably cause heating.

A highly fusible alloy rarely, if ever, gives timely warning before running out, whereas a Magnolia-lined bearing heats so slowly that it permits of either shutting down or cooling off the bearing, while running, without injury to shaft or bearing, and we shall recite cases where entire lack of lubrication has done no harm.

Tin is not the only metal that lowers the melting point of an alloy.

It is most natural to suppose that the melting point of a lead-antimony mixture would not be lower than lead, but that the addition of antimony would even make it higher. The eutectic of this series is 87 per cent. lead and 13 per cent. antimony and the melting point is 447° Fahrenheit, or 212° Fahrenheit less than the mean of the two metals.

It is a common practice to guarantee the melting point of babbit metals to be 600° Fahrenheit, and over, and to view this practice from a charitable standpoint, this guarantee is doubtless given because it is taken for granted that such ought to be the melting point. It is quite evident that the guarantors are not hampered by facts and have no definite knowledge upon which to base their assertions, but they run no risk of detection as buyers are just as much in the dark.

We have a Die-Casting Catalogue of recent date in which is given the melting point of their Genuine Babbitt as 810° Fahrenheit. We believe these figures were obtained from a college laboratory, which gives absolution from intentional misrepresentation, as it is highly improbable that such a wonderful alloy exists, but like many other babbitt manufacturers, they don't know any better.

(Continued next month.)

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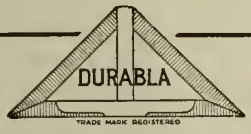

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Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

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Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

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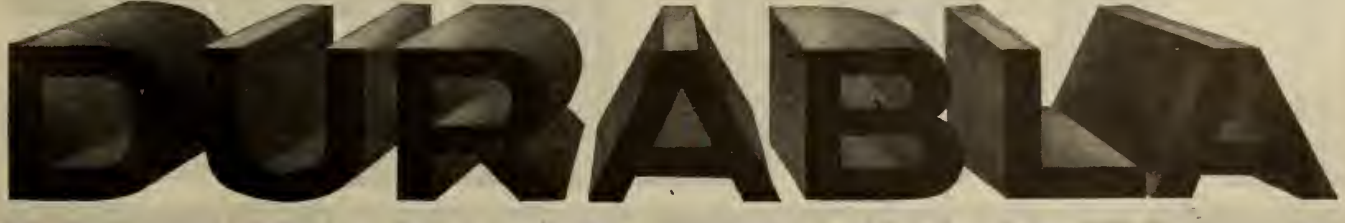

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6 Reasons

1 This multi-piece bracket construction—a patented feature—made the building of LONG ARCHES possible and has blazed the trail in the development of modern furnace construction in which long arches are used exclusively. The bolted brackets hold the beams in alignment and absolutely maintain the unity of the structure which is designed to "stay put."

2 These cast iron brackets cannot warp or twist, and the high web carries the heat away from the bulb imbedded in the tile, thus prolonging the life of the bracket; however, any section can be removed or repaired, without disturbing the balance of the structure.

3 Heavy brackets on the extremities of the cross beams rest on and spread the weight over the side walls. All expansion is taken care of within the arch itself and there is absolutely no side thrust on the furnace walls.

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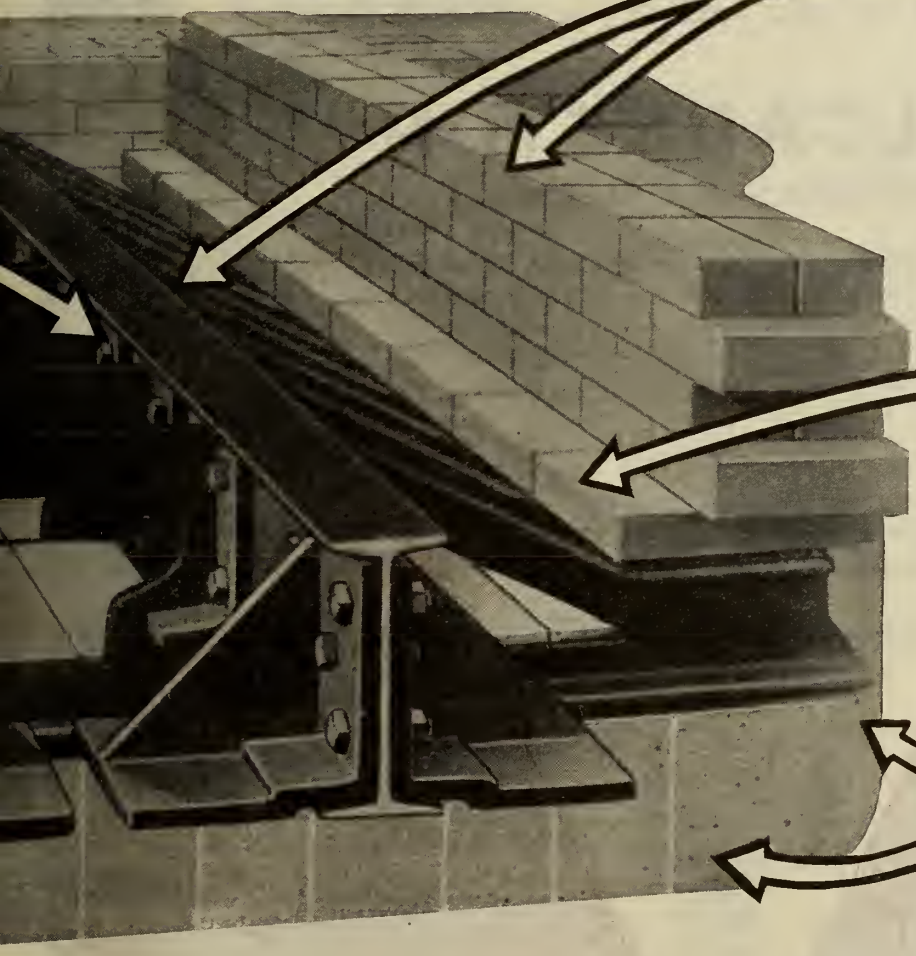

4 The bracketed cantilever construction carries the Arch well out past the last cross beam, so that perfect ventilation is obtained between the curtain wall and this beam, as well as around all the rest of the ironwork.

5 The curtain wall is supported by flat tile resting on the brackets, and is absolutely independent of the Arch Tile. The Arch Tile can be removed or replaced without disturbing the curtain wall.

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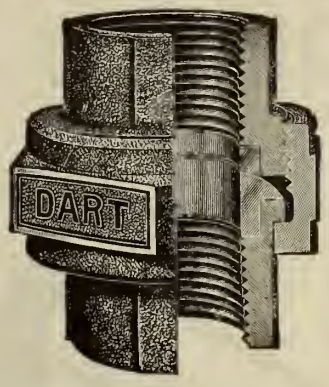
Dart Unions



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All boiler manufacturers agree on and emphasize the fact that their boilers burn fuel most efficiently and economically when the furnace fire and water in the tubes are permitted to come into contact with each other with a minimum of interference. Thus, boilers whose tubes are kept free from soot, ash and scale accumulations consume less fuel in order to maintain a given steam pressure than boilers which are regularly neglected, or only partially cleaned.

Vulcan Soot Cleaners assure thorough cleanliness so far as the soot and ash are concerned. They are responsible, in most plants where used, for saving between 4 per cent. and 8 per cent. of the fuel consumption, or for reducing the preventable losses 20 per cent. to as high as 40 per cent.

While you're thinking of it, write and ask for the interesting folder, "SPENDING $796 TO SAVE $1,017.40!"

Vulcan Soot Cleaners are manufactured for all types of water tube and return tubular boilers, superheaters and economizers. For quotations, write to either Canadian office, giving type of boiler, number of tubes wide and high, and steam pressure.

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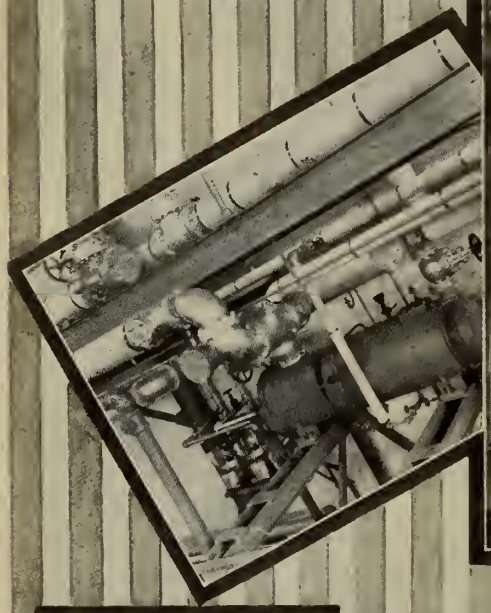

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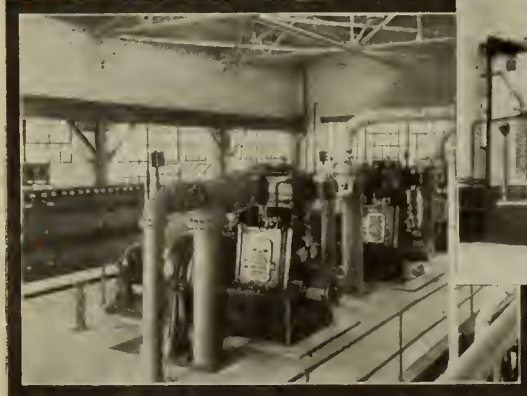

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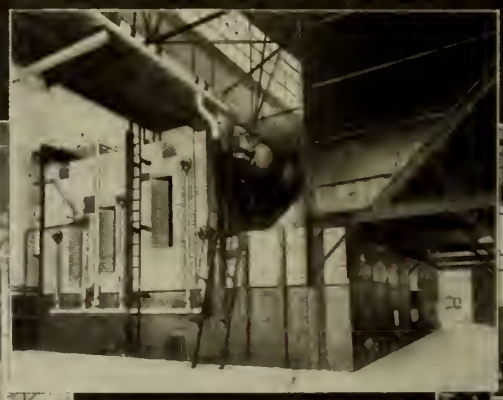

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Oil Fuel From the Well to the Consumer*

The Stratification and Processes of Distillation of Crude Oil are Explained, and a Number of Applications of Oil Fuel Burners To Furnaces With Natural and Forced Draught are Given.

By J. H. WILLIAMS

NATURE has hidden in the earth and in the waters under the earth many things useful to man, but there are few, if any, more useful to man than oil, and the term "struck oil" has become familiar as an expression for having acquired riches.

Origin.—The origin of petroleum is not known with any certainty, but a widely held theory is that it was formed during the carboniferous periods of the world's history by the decomposition and destructive distillation of the vast marine vegetation and animal organisms then existing, much in the same way that the coal measures were formed from terrestrial vegetation. Formerly much more of the world's surface was covered by water than at present and there were many shallow seas or swamps where the slowly rotting marine growths were deposited with sedimentary sands and calcareous matter of marine organisms, and as ages passed these deposits were covered over and sealed in. Under the effect of heat and pressure through a long period of time these organic deposits were decomposed and formed liquid petroleum and gas, and remained in the porous strata of sand and lime until the present day. It would appear that such deposits should naturally be horizontal, but during the cooling of the earth's surface volcanic movements have occurred, and probably due to contraction, have resulted in wave-like formations or curves presenting the appearance of low rolling hills and valleys. Petroleum is usually found where the earth's movements have not been of a very violent nature.

Referring to Fig. 1 the cap of the curve is termed the "Anticline" and the hollow the "Syncline." The well is usually drilled in the slope of the anticline in order that the greatest amount of oil can be drawn off in the most economical manner. Salt water is nearly always found in petroleum wells and being heavier than oil is found in the lower part of the anticline or in the syncline, while the gas, if there is any, collects under the cap. The pressure of the gas forces the oil up the casing and saves the cost of pumping.

Locating a position for an oil well is not as simple as it may sound, even when the presence of oil is suspected in a district. The most common surface indications are "seepages" or leakage of oil to the surface from its underground source. Seepages are fequently deceptive because the subterranean pool may be a considerable distance horizontally, sometimes miles, from the surface position of the seepage.

In Fig. 1 the strata are shown running parallel to the surface and parallel to each other, it is quite easy to imagine that the strata do not always arrange themselves in such an orderly manner. In the case of a fault as shown by diagram Fig. 2 the oil would probably leak from the oil sand under gas pressure and travel under the overlying impervious strata of clay and limestone until it met a pervious formation through which it could filter up to the surface.

Locating a well is not an exact science but is generally the result of much labor and thought on the part of expert geologists.

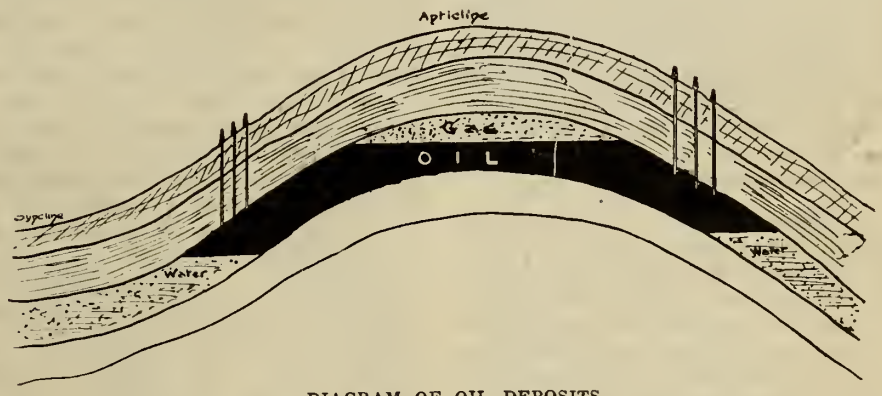
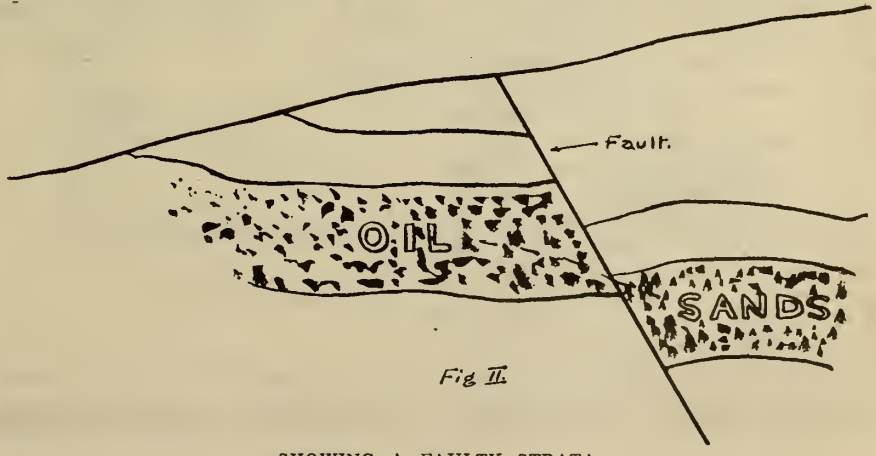


DIAGRAM OF OIL DEPOSITS.

Winning Oil.—Drilling operations. Petroleum wells are drilled in a somewhat similar manner to drilling for water.

The outfit is generally referred to as the "Rig" and the type of "Rig" to be adopted is determined by local conditions and the strata through which the bore passes.



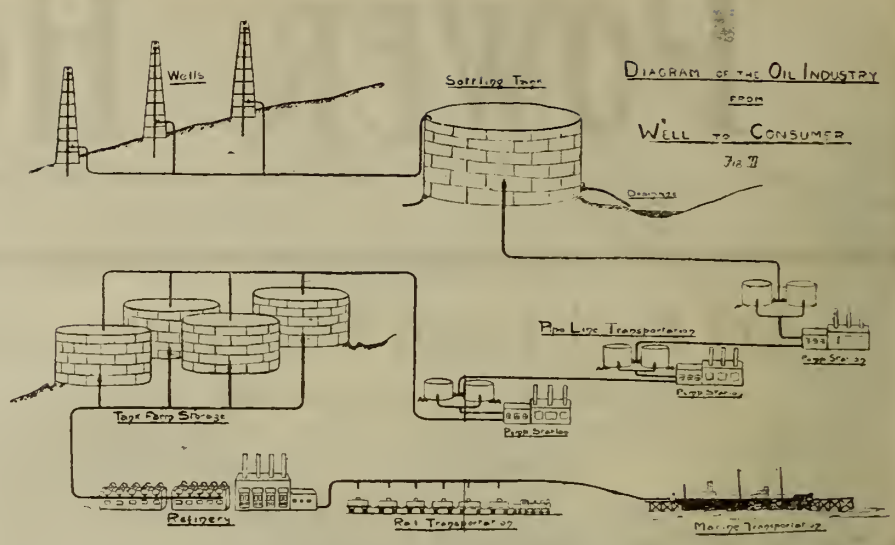
SHOWING A FAULTY STRATA.

*Transactions of the Institute of Marine Engineers.

There are two systems of drilling: (1) The standard or percussion system. (2) The rotary system.

First a hole is dug, and over the hole a derrick is erected about 80 feet in height and 24 feet square at the base. This derrick has to support the well casing and the string of tools. Drilling is more rapid with the rotary system than with the percussion up to about 2,000 feet depth, at which point there is very little difference in the rate. The standard system has some advantages of its own, depending upon the formation passed through, in the hardest formations the well will more nearly approach the vertical. In the standard rig there are two pulleys on the top of the derrick, one carrying the cable with the string of tools, and the other carrying a rope with the bailer. The rope carrying the tools is fixed to one end of a beam or lever called the walking beam, and the other end of the beam is operated by a steam engine. (Before any oil is discovered the boiler is fired by wood cut from the bush around and if the well is not a "dry hole" it is subsequently "oil fired"). This gives the necessary motion to the tools. The drill stem or bit is operated for a certain number of hours, according to the nature of the strata through which the boring is passing when it is taken off to be "dressed" or sharpened, and while this tool is being changed the bailer is connected up and the water and borings made by the drill are pumped out. This operation proceeds night and day.

All wells require to be cased to prevent the sides caving in, and to prevent the infiltration of water. In Mexico casing usually starts with a 14-in. or 12-in. steel pipe and finishes up with a 6-in. or 4-in. pipe. The casing follows the drill, thus while the string of tools works in the casing the point of the drill is always ahead of the casing. The rotary system is mainly used for sinking deep wells through loose or soft formations. The operation consists in rapidly turning a column of pipe at the end of which is a special tool for cutting the formation through which it is passing. To wash out the cuttings, and so leave a clear surface for the cutter to work upon, water is forced through the pipe under such pressure as to cause it to return to the surface on the outside of the pipe. By this means a column of pipe can easily be sunk through beds of sand, gravel or other soft formation which otherwise through their lack of stability would render it very difficult to first drill a hole and then insert the pipe or casing to form the wall of the well as in the percussion system. It takes anything from 60 days to 300 days to drill a well, the rate of drilling being much retarded where there are serious water troubles, or beds of hard rock. Wells vary in depth from 500 ft. to 4,000 ft., generally the deeper wells produce the lighter gravity oils. The oil bearing strata or producing sands vary from 200 ft. to 500 ft. in depth.



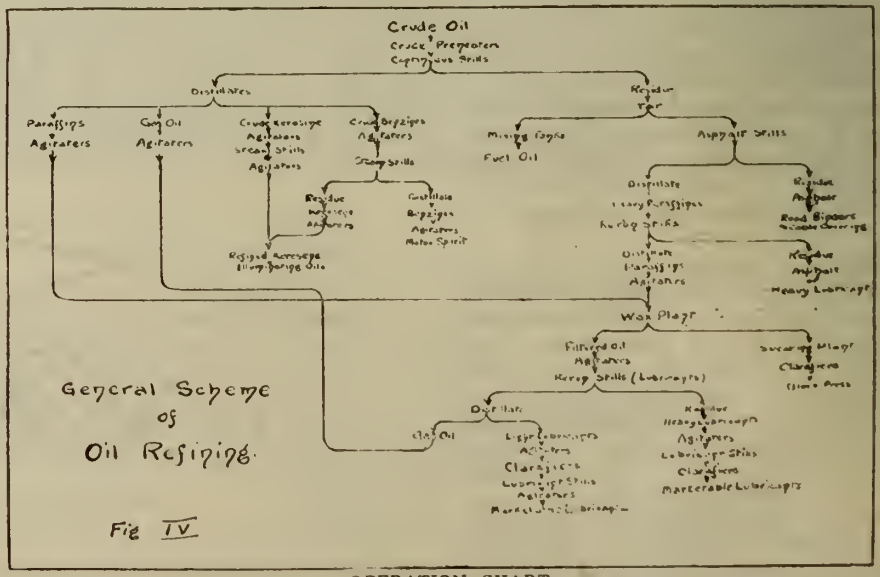
FROM WELL TO CONSUMER.

Some years ago particulars were given in an American publication of the cost of completing an oil well in California. It was then stated to be anywhere from £2,000 to £20,000, depending, of course, upon the strata through which the well is drilled. In a proved oil country the estimate was £2 to £3 per foot. When exploring new fields, of course, the cost of every "dry hole" must be added to the cost of the producing wells; from this it will be easy to see why oil is not exactly given away, especially when for every producing well two "dry holes" are bored, and it has been stated that for all the producing wells about 70 per cent. yield less than 100 barrels per day (about 14 tons).

Storage.—The crude oil when first brought to the surface is found to contain water and dirt, generally sand, and is of a dark brown or black color, and is very rarely a light color or transparent. From the well the oil is run or pumped into a preliminary storage tank, where the sand and water are allowed to settle out before the oil is transported to the refinery. Fig. 3 illustrates diagrammatically the progress of the oil from well to consumer.

Light oils are refined as soon as possible to avoid evaporation of the volatile constituents. Heavy oils can be stored for a considerable time without great loss. Steel tanks are usually employed for storage of oil, but heavy oils can be stored in clay or earth reservoirs covered with a wooden roof. This is a very cheap method of storage, but is not highly recommended because the walls of the reservoir have been known to be washed away when a heavy rainfall occurred.

Transportation. Land and Ocean.—The value of oil depends upon its availability. Inaccessible fields require pipe lines of great length. The location for a pipe line is determined by the topography of the district through which the line passes, in much the same way as a railway line; it is obviously not advisable to carry a pipe line over a mountain or through a lake if it can be avoided. Main pipe lines are generally 8 in. diameter, the tendency being to increase the diameter for the heavier and more viscous oils.



OPERATION CHART.

The 8-in. pipe weighs 28 lbs. per foot, and has a cubic capacity of 47 tons per mile. The principal factors in transportation of oil, either by pipe line or ship, are its physical characteristics as

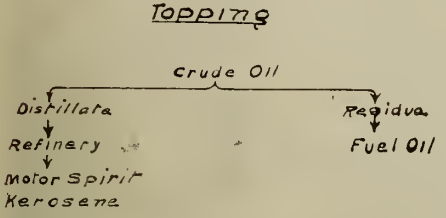
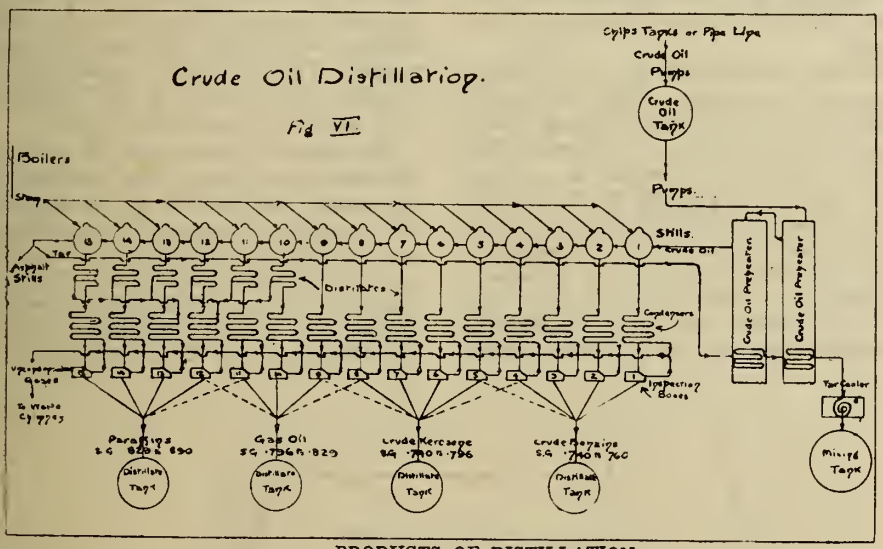


FIG. 5.

regards gravity and viscosity (otherwise its weight and resistance to pumping). The method adopted to overcome the difficulty is to heat the oil to a temperature of about 120 degs. Fah. depending upon the nature of the oil.* High temperatures cause gasification, and give trouble at the pumps, the heating therefore should be carried out on the delivery side of the pump. The capacity of a pipe line is determined by the working pressure at the pumps, the viscosity of the oil (which is due to composition and temperature), and the climatic conditions (temperature and rainfall) and the distance between the pump stations. The capacity of a pipe for oil increases faster than the square of the diameter because the friction decreases with increase of size. A pipe line consists of: 1, Field station; 2, Intermediate stations. 3, Terminal station.

The field station consists of a large number of storage tanks, two or more horizontal duplex pumps, with the necessary boilers, condensers, feed and circulating pumps, electric lighting and exhaust steam heaters for heating the oil preparatory to pumping it to the first of what we will call intermediate stations. The intermediate stations are very much like the field stations, but there is less equipment, only two storage tanks being necessary and they are usually of smaller capacity than on the field or terminal stations. While one tank is receiving the oil from the preceding station, the oil is being pumped from the second tank on to the following station on the line. The terminal station consists of from 20 to 50 storage tanks and the pumps are constructed for a lower pressure, the duty being to deliver the oil into the refinery or to tank steamers for export. The pumps are duplex, triple or compound, depending upon the supply of fresh water available at the station, if good boiler water is not available triple expansion pumps are installed with ample evaporators.

Through an 8-in. line, 32 miles long, from Potrero to Tuxpam, 5,000 tons per day are pumped. There is one field station, two intermediate stations, and the receiving station at Tuxpam. The latter is situated on the coast of the Gulf of Mexico at the mouth of the Tuxpam River, but as there are only five feet of water on the bar the ships lie one mile off the shore and pipe lines are laid on the sea bed with a flexible hose at the sea end, and here the ships are loaded without entering port. Another 8-in. pipe line runs from Potrero to Tampico Refinery, a distance of 100 miles. On this line there are 8 pump stations, and 3,500 tons per day are pumped to the refinery at a pressure of 600 to 800 lbs. per square inch. We have now brought the oil to the refinery.



PRODUCTS OF DISTILLATION

Refining.—The question is frequently asked, "What is petroleum?" The chemist will tell you that it is saturated hydrocarbons and then we are not much wiser. So far the chemist has only touched the fringe of the subject, there is every probability that in the future as many products will be obtained from oil as are now produced from coal. Crude petroleum is a mixture of hydrocarbons in variable proportions with small quantities of oxygen, nitrogen, and sulphur present as impurities. Except on the oil fields, and at the pump stations, where no fuel oil is available, crude oil is very seldom used as fuel, the crude oil is always treated or refined and made into marketable products. Most crude oil as obtained from the wells are unsuitable for fuel. The object of the refiner is to subdivide the crude oil into fractions suitable for the different uses to which they are to be put.

At the present day the demands of trade call for principally:

(a) Benzines for motor fuel, cleaning and manufacturing.

(b) Kerosene (frequently called paraffin) for illuminating; also used for motor fuel.

(c) Lubricants (lubricating oil is one of the most valuable of petroleum products).

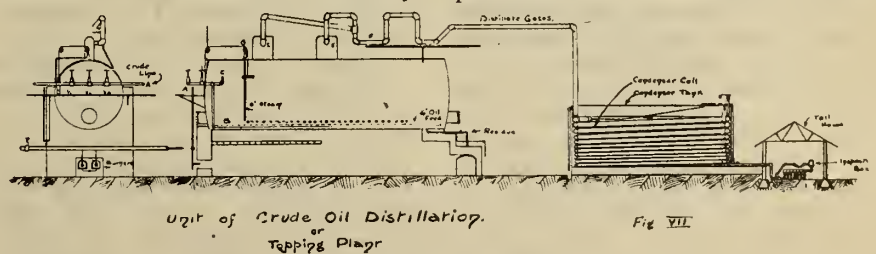
(d) Fuel oil (about 40 per cent. of all crude produced is used as fuel.)

Refineries may be roughly divided into two classes:—

First.—Refineries which treat the whole of the products obtainable from the oil by distillation, see diagram Fig. 4.

Second.—Topping plants which treat the oil with the object of obtaining only a high grade distillate (a) and (b) and a residue (c) and (d) for fuel oil, diagram Fig. 5.

In a complete refinery treating the whole of the products the crude oil is treated in a series of stills, the process is shown diagrammatically in Fig. 6, where the gasoline or benzine, kerosene, and gas oils leave the stills as a distillate, and the residue is a heavy tar or fuel oil. The benzines are further refined in steam stills. The kerosenes are also sometimes redistilled in the steam stills if a high grade produce is required, and they are treated in vertical tanks called "Agitators," where they are made "water white" by agitation with sulphuric acid and caustic soda. The residue is a heavy tar oil which can be used straight as fuel if facilities for heating to the proper temperature are available. In the Mexican Eagle Oil Refineries oil of a gravity S.G. 1.04 is used as fuel. On board ship fuel of a lighter gravity is preferred.



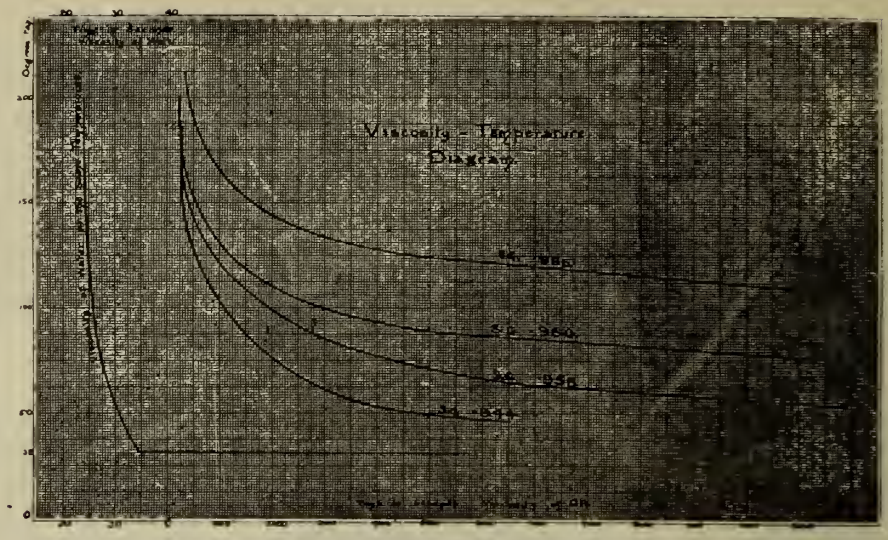
A TYPICAL UNIT.

The crude oil is pumped from the storage tank through the forewarmer to the continuous stills. The process is continuous, i.e., the crude oil enters No. 1 still, then passes on to No. 2 and so on until

*See diagram, Fig. 8.

it leaves the last still as a residue. In each still a fraction of the oil is distilled off, passes over as gas into the condenser coils where it is cooled by the surrounding water and leaves the coil as a liquid, this liquid passes into what is known as a "Tail House"; here are a number of inspection boxes (one for each still), with glass sides where the quality of the distillate coming over is observed and its gravity tested frequently. The tail house is a kind of "Junction," where the distillates are directed to their respective tanks according to their quality.

In the diagram Fig. 6 stills 1 to 4 are shown as distilling off petroleum spirit, 5 to 8 kerosene or illuminating oil, 9 to 11 gas oils, 12 to 15 heavy gas oils or heavy paraffins. If No. 4 be heavily fired it might easily happen that the distillate would have to be directed to the kerosene tank, also if 4 and 5 be lightly fired then the liquid at No. 5 "look box" would be diverted to the spirit tank instead of the kerosene tank. The crude oil left the storage tank at atmospheric temperature, and the residue finally leaves the last still at a temperature of 600 degrees Fah. The continuous stills are in appearance much like Lancashire boilers, some being "through" fired and others externally fired, they are all fired by oil fuel of the heaviest gravity. The fractions we have now obtained are still further refined. The crude spirit is gently heated in a steam still (which is a cylindrical tank with a steam coil) and the distillates are known as "aviation spirit," "motor spirits" of several qualities, and cleaning spirit, the residue, if there is any, will be kerosene. The kerosenes are treated in agitators with sulphuric acid and caustic soda, where all trace of the tar is removed and they are then ready for market. The gas oil requires no special treatment, it is used to enrich town gas, is mixed with heavy residues to make fuel oils, and is used as fuel in Diesel engines. The heavy paraffins, so called because they are heavily charged with paraffin wax, are an important fraction, because when the wax has been removed lubricating oils are obtained. The extraction of wax is an expensive process, but when ready for market it is a valuable product. The paraffin oil is chilled to a temperature of 30 degrees to 32 degrees Fah. when the wax crystallizes, and on being pumped through a filter press the wax crystals are left on the canvas filtering medium and the oil passes out free of wax, ready to be treated in the lubricating oil stills. The lubricating oil stills are oil fired, the distillate is gas oil, and the residue lubricants. The wax requires some further treatment before it is ready for market, the crude wax is rather soft and of a yellow color, but the finished product is hard and white. Lubricants also require further treatment, marine engine oil for instance requires an admixture of vegetable oil, because pure mineral oil will not saponify. You cannot obtain a lather from pure mineral oil



VISCOSITY TEMPERATURE DIAGRAM.

and water. If you have an oil that will not lather freely with a slight admixture of water, leakage from glands of reciprocating engines will wash away the oil from the bearings. In the case of turbine engines the lubricant must not be allowed to emulsify, therefore only pure mineral oil must be used for turbines.

So far we have followed the distillate through the refinery, but the tar oil which left the continuous stills as a residue is capable of further treatment. That portion of the tar oil which is not made into fuel oil is pumped to the asphalt stills, where the distillate is a heavy paraffin which is treated for extraction of wax and lubricants, and the residue is asphalt, the latter being largely used for road making and cable construction In these stills the tar enters at 450 degrees and the asphalt leaves at 750 degrees to 800 degrees Fah. according to the grade of asphalt made.

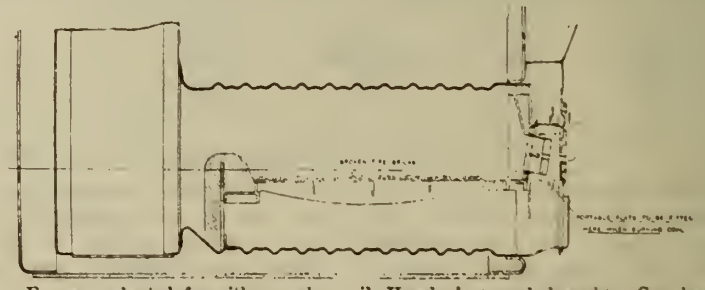
A topping plant is the simplest form of refining, it is sometimes adopted where there is a big demand for fuel oil. The light fractions are extracted by distillation and then transported to a refinery, where they can be treated and made into marketable products. The residue, as it contains all the gas oil, makes an excellent fuel of low viscosity and high calorific value. Fig. 5 represents a topping plant.

Ships.—From the refinery the oil is shipped by pipe line, tank wagons, and tank steamers to consumers in all parts of the world.

Pipe lines we have already discussed, tank wagons need no description, and tank steamers are well known to all marine engineers; they are steel boxes divided into compartments, with an engine and funnel at the after end. This appears still to be the view of many people. They are the pariahs of the shipping world when in port, and the most comfortable ships at sea.

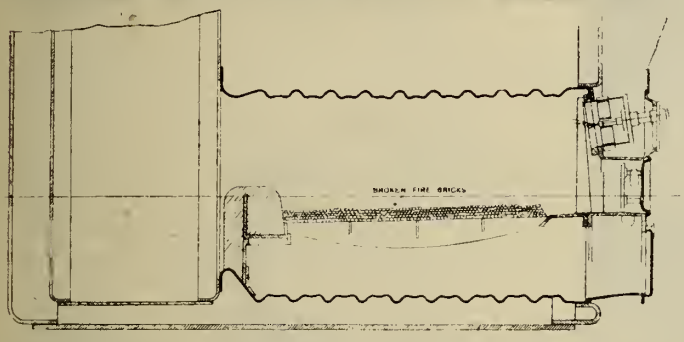
The tanker is to-day one of the most efficient ships afloat. She requires no stevedores for loading or discharging, and is capable of discharging a full cargo in less than 24 hours, the time depending upon the class of oil. The San Fernando of the Eagle Oil Transport Company is 18,000 tons d.w. capacity, and the cargo can be discharged in 18 hours under favorable conditions. The accommodation for officers and crew is luxurious compared with only a few years ago. There is accommodation for 12 passengers. Every ship in the fleet is fitted with refrigerating plant for fresh provisions, so that "salt horse" and "Harriet Lane" are almost unknown to the modern tanker. The only drawback from the officers' point of view is the short stay in port, one vessel recently made a return voyage to the Gulf of Mexico in 40 days, 10,000 miles steaming with 48 hours loading (from time of entering to leaving port).

We have now brought the oil to the

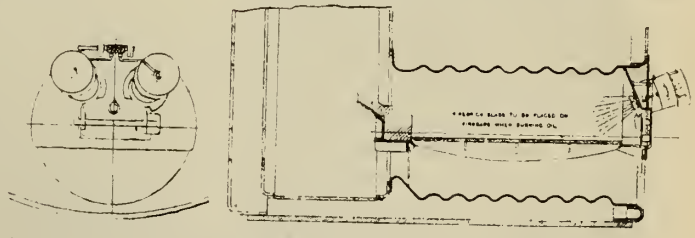


Furnace adapted for either coal or oil, Howden's forced draught. Can be changed over by merely moving broken brick and air directors or vice versa.

consumer and endeavored to show something of the nature of the stuff; it may be in order to add a few remarks regarding the handling of fuel aboard ship. It has already been remarked that 40 per cent. of all oil produced is used as fuel, and the possibilities of increased oil production in Mexico are very great, at the same time the demand for oil is increasing enormously. The superiority of liquid fuel over coal is now unchallenged and the question of its adoption is simply a matter of supply and the price at which it can be purchased. It has been said that oil won the war, and it may well be true, for the Allies controlled about 90 per cent. of the world's total production. Oil is a natural fuel for ships compared with coal, and it is now cheaper, easier to handle, and more efficient to use. Three oil fired ships will yield the same efficiency as four ships of the same tonnage burning coal. Oil with a flash point above 150 degrees Fah. is safer than coal, oil is not liable to spontaneous ignition, but if heated beyond its flash point it gives off gas that will ignite. The danger from fire is small and not greater than in the case of coal. In nearly every case of a fire in the stokehold of ships burning oil that has come to the notice of the author the cause was the leakage of hot oil from the burner or pipe at the furnace front, the usual cause is from an unlighted burner where the valve is left open and the oil runs unseen from the furnace into the bilge, and later when the burner is lighted the fire occurs. The real cause is pure carelessness.



Boiler with Howden's Forced Draught, furnace front being made to burn oil with firebars in place. Can burn coal or oil, or both together. Change from coal to oil made by covering bars with broken brick.



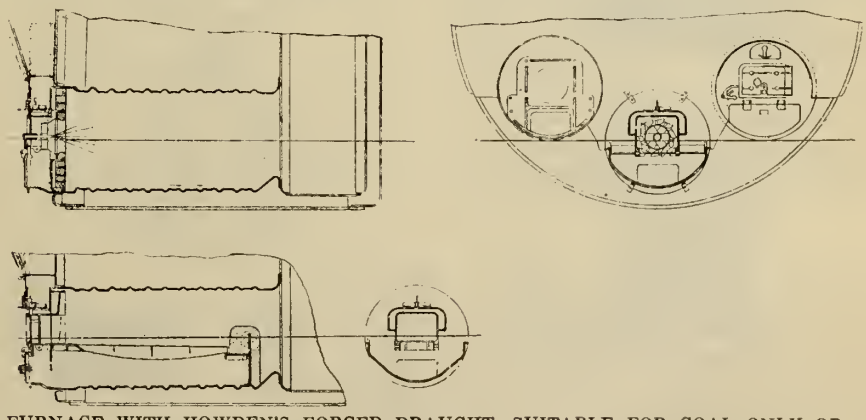
Arrangement with natural draught to burn coal or oil or both. When using oil only bars are covered with slabs.

Fuel Oil Installation. — Successful burning depends as much on the condition in which the oil is delivered to the burner as upon the type of burner. There are many fuel oil burning "systems" on the market, all more or less good. It is an axiom that the most simple installation is the most efficient, other things being equal. The first part of the installation is the bunker. The ordinary double bottom tank will carry oil satisfactorily, but they are not recommended in the case of new vessels where it is possible to have specially constructed bunker tanks owing to the danger of contamination of the fuel with water. The presence of the latter is a distinct disadvantage; besides lowering the heating value it may, in the case of heavy fuels, cause priming in the supply tank, and steam pockets in the heaters and fuel pipes to the burners. Where fuel oil is carried in double bottoms, settling tanks are necessary, where the water can be drained off. Two tanks are necessary, one being in use for separating the water, and the other acting as supply tank for the fuel pump. A steam coil is required in each tank, even if the oil is free from water, to maintain the temperature at about 80 degrees to 90 degrees Fah. to make the flow of oil to the pump easy. Strainers should always be fitted on the suction side of the pump. The fuel pump takes the oil from the supply tank through the suction strainer and delivers it through one or more heaters to the burners. The fuel pump should operate at a low piston speed, have a long stroke, and all clearances and spaces where gas pockets can form should be reduced to a minimum, the suction lift should be as low as possible. The steam driven reciprocating pump has so far held the field, but a rotary pump that would stand high pressure and give a steady delivery pressure would be ideal; there are, however, plenty of drawbacks to all the rotary pumps at present on the market. In burning fuel oils the viscosity of the oil plays an important part because success depends on the pulverization of the oil into sufficiently fine particles to ensure efficient mixing with the air admitted to the furnace, and naturally the more viscous the oil the greater the resistance to disruption. Viscosity is molecular friction, i.e., resistance to change of form, and is an expression of the time taken by a given quantity of oil to flow through a standard orifice, it is expressed in seconds. Viscosity decreases rapidly at first with rise of temperature and then more slowly as shown in diagram Fig. 8.

The mechanical atomiser is without doubt the most suitable for ships' use, and in all oil burning installations on the pressure system the fuel heater is in the author's opinion not even second to the burner. Its function is to raise the temperature of the oil to as near the firing point as convenient and to reduce the viscosity so that when forced through the sprayer the oil will enter the furnace in the form of a very fine spray or mist. There are several types of heaters in use, the most common being the condenser type and the coiled tube type, the latter is simpler and more efficient as indicated in diagram Fig. 9, which is abstracted from a paper by M. Boilla, Italian Corps of Naval Architects, which was published in "Engineering," Vol. 103, No. 2,670; this paper covered tests of oil coolers, but of course will hold good for oil heaters.

Fig. 9 is specially interesting as it shows that the spiral coil cooler 4 (or heater) is about twice as efficient as the condenser type 5, considered as a heat transmitter, besides being very much simpler in construction.

One cannot emphasize too much the importance of bringing the oil to the furnace in such a state that combustion will be rapid. In the case of oil burning the rate of combustion must be rapid because the fuel is in motion and as soon as the oil spray enters the furnace it is carried forward at the same velocity as the air of combustion. The velocity with ⅝-in. water pressure at the furnace will

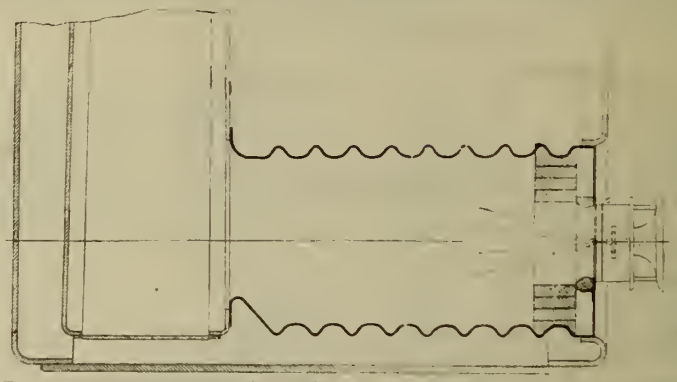


FURNACE WITH HOWDEN'S FORCED DRAUGHT, SUITABLE FOR COAL ONLY OR OIL ONLY.

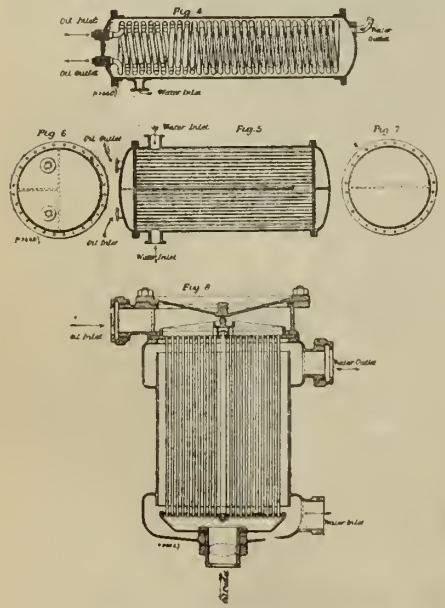
Types of Oil Coolers.	Weight.	Diameter.	Height or Length	Space taken up	Cooling Surface.	Weight.	Space taken up.	Coefficient of Transmission.
	Lbs.	In.	In.	Cub. ft.	Sq. ft.	Per sq. ft. lb.	Per sq. ft. cub. ft.	B.T.U.'s per sq. ft., per deg. F., diff. per hr.
Oil Cooler, Figs. 1 and 2..	= 772	31.6	39.4	17.7	28	27.6	0.62	33 to 59
Oil Cooler, Fig. 3	=1,234	13.8	110.3	9.5	484	2.56	0.02	.. to ..
Oil Cooler, Fig. 4	= 992	15.7	118.1	13.4	215	4.61	0.063	66 to 73
Oil Cooler, Fig. 5	=1,543	23.6	66.9	17	204.52	7.54	0.084	25 to 35
Oil Cooler, Fig. 8 ..... (two elements).	= 265	12.6	13.7	2.3	62	4.26	0.038	136 to 180

be 22 ft. per second, and with a length of furnace only 7 ft. it means that every particle of oil sprayed into the furnace must combine with the oxygen of the air, and be converted into CO_2 in the space of one-third of a second, if combustion is not completed in one-third second some of the unburnt oil comes in contact with the relatively cold furnace plate or tubes, and adhering thereto forms a tarry mass which becomes converted into carbon by the heat of the furnace. In effect the furnace is turned into a still, the fluid portion of the oil only is burned and the solid carbon remains in the furnace. The same trouble will sometimes occur due to a dirty burner nozzle, when some of the oil is allowed to impinge on the furnace tube, combustion is checked and carbon forms. As soon as the formation of carbon is noticed it should be removed to prevent the danger of local overheating, this point cannot be too strongly insisted upon. The temperature to which oil should be heated depends entirely upon the kind of oil used, each oil must be treated on its own merits. As a general rule the oil should be heated to a few degrees below its flash point, if heated above its flash point gas will form in the pipes and result in irregular intermittent flame at the burners.

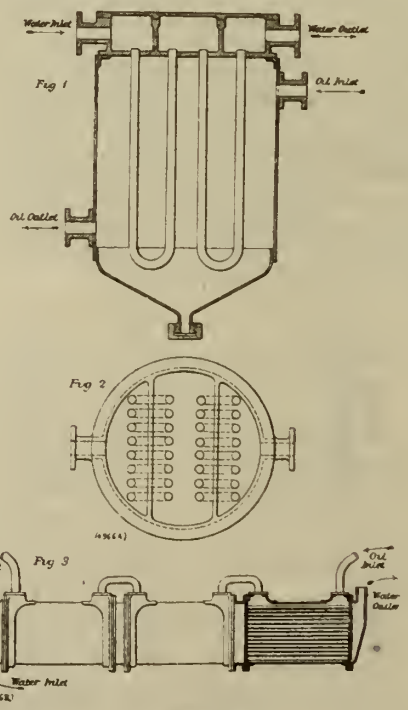
Fig. 10 shows five different furnace arrangements of oil burning. The arrangements shown on illustrations A B and C are advised by the makers when the change from coal to oil fuel and vice versa has to be frequently carried out and time does not permit of removing the firebars and backbridges as with these arrangements the time of conversion from oil to coal and vice versa is a matter of minutes only. The arrangements indicated on illustrations D and E are to be preferred where time will permit of the removal of the coal burning gear as indicated. Forced draught is preferable to natural draught. (Drawings for Fig. 10 were kindly lent me by the Wallsend Slipway & Engineering Co., Ltd.). As the fuel is in motion and not stationary as in the case of coal burning, grate area is not a factor, and furnace volume takes its place. It is furnace volume with correct admixture of air that determines the amount of fuel that a boiler can consume. One of the advantages of burning oil is the simplicity of control of the air necessary for combustion. On the other hand this may prove a disadvantage in careless hands, because it is much easier to lower the efficiency of the furnace, by admitting an excess of air, than is possible with coal. Oil usually requires about 250 cubic ft. of air per lb. of oil. The air for combustion should be raised to a temperature of not less than 300 degrees Fah. before entering the furnace; it is obviously wrong to raise the temperature of the oil to 200 degrees or 220 degrees and then admit air at 120 degrees.



Furnace arrangement for oil burning only, natural draught. To burn oil. fire bars, etc., must be stripped.



OIL HEATERS.



OIL HEATERS.

GIFT TO C. A. S. E. LIBRARY

Mr. B. G. Newton,
Manager,
Power House,
143-153 University Ave,
Toronto.

Dear Mr. Newton:—

I have been requested by Mr. A. Heath, Sec. Hamilton No. 2 C. A. S. E., to thank you most heartily for your generous contribution to our library, and can assure you that the volumes will be read with deep interest.

Bro. Heath would have written you himself, but owing to him being taken with a sudden illness he was unable to do so.

Wishing you and your paper every success.

Yours sincerely,
L. J. ELLIS,
Secretary.

The above letter was in acknowledgment of a number of books from the technical book department of the Maclean Publishing Co., presented to the C. A. S. E. through Mr. Newton, manager of Power House.

A Bulge in the Steam Drum of Water Tube Boiler

SEVERAL months ago a boiler failure occurred in the power plant of a large automobile factory, and as it was of unusual character, a brief description of it will be of interest. The boiler referred to is of the water-tube type, and has 252 tubes each 4 inches in diameter and 18 feet long, and two drums, each 48 inches in diameter and 20 feet long. The heads of the drums are 19/32 of an inch in thickness, and the shell plates are 15/32 of an inch thick. The longitudinal seams of the drums are quadruple-riveted, with double-butt straps, and have a calculated efficiency of 93.1 per cent. The boiler is operated at a pressure of 200 pounds per square inch.

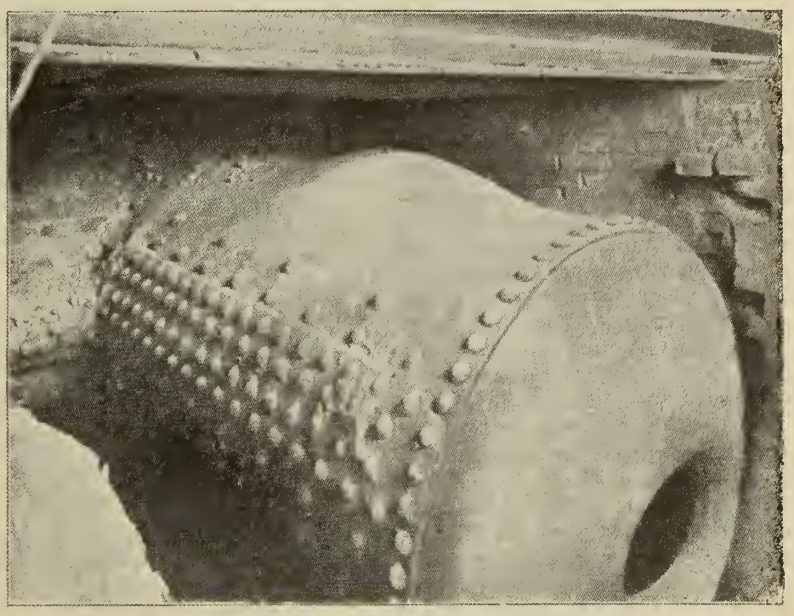
Previous to the failure the boiler had been cut out of service in order to make some maintenance repairs, and after these had been completed the boiler was filled with water for the purpose of applying a hydrostatic-pressure test. It was impossible to raise the desired pressure within the boiler, however, and the discovery was made that water was running down on the brick-work and between the tubes. Some of the brick-work at the rear of the boiler was removed and it was found that a bulge 42 inches long, 36 inches wide, and 6½ inches deep had developed in the upper shell plate of one of the drums, directly beneath the smoke breeching, and that there was an opening about three inches long in the plate at the centre of the bulge. This bulge is clearly shown in Fig. 1; and its location on the drum, and the general arrangement of the drum and breeching are shown in the line drawing Fig. 2.

The apparent explanation of this failure is that the shell of the drum became locally overheated; that the bulge was formed by the action of the internal steam pressure on the overheated part; and that finally a small opening developed at the centre of the bulge, due to the reduction in the thickness of the metal at that point.

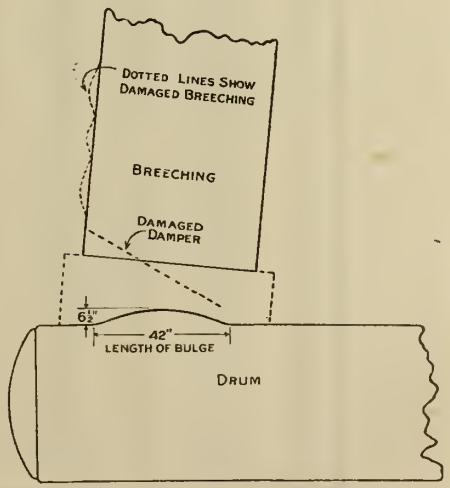
If we assume that the drum shell failed because of overheating of the metal we must assign a cause for such action. Bags and bulges in boilers are usually caused by accumulations of oil, grease, or scale, which have been deposited on the interior parts of boilers directly exposed to the flame and the products of combustion, and which form a non-conducting coating between the heat on one side of the metal plate and the water on the other side. For obvious reasons it is unlikely that deposits of this nature could have caused the trouble in the present case.

It seems probable that combustible material of some kind accumulated on the outside of the upper part of the drum where the bulge developed and, becoming ignited, caused the metal to soften and stretch under the action of the internal steam pressure. The kinds of combustible material that might have caused the damage in this particular location are practically limited to two—soot (in which may be included flue dust and cinders) and shavings. It seems rather unlikely that a dangerous temperature could have been brought about by the combustion of soot alone, under the prevailing conditions, although it is well known that this material, when deposited in combustion chambers and elsewhere about boiler settings, will remain at a high temperature for several days after the fires in the furnaces have been extinguished; and in many cases men have been seriously burned by putting their feet or hands into these hot deposits when cleaning or inspecting boilers.

There is the further possibility, however, that shavings, which were used in part as fuel for the boiler furnace, were carried along by the draft through the gas passages to the stack at which point the velocity of the current of hot air and gases became reduced so as to be no longer strong enough to sustain the shavings, which then dropped on to the top of the drum. These shavings may have become ignited, and if a considerable quantity had accumulated previous to the ignition, the resulting heat may have caused the damage.



VIEW OF BULGE IN TOP OF DRUM.



SHEWING LENGTH OF BULGE.

Fortunately, no personal injuries resulted from the accident, and the property loss was limited to the expense involved in repairing the damaged shell plate of the drum. On account of the large size of the bulge and the high pressure carried on the boiler, it was recommended that a new course be substituted for the damaged one, rather than to attempt to force the bulge back into position and apply a patch. It was also recommended that doors be placed in the brick work between the breeching and the drums on the boiler, to give access for cleaning out accumulations of soot, as often as might be found necessary.—Traveller's Standard.

Power for London.—The Ontario Power Commission has approved of plans for cost $35,000, to accommodate the new industrial area that the city has established there. Work will begin at the first of the new year and filtration equipment will also be installed at the Horton street pumping station at a cost of $55,000.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE HAVE dealt in the last article with the latent heat of steam, and have of course assumed that we were dealing with saturated steam. It would be as well at this juncture to define the different kinds of steam with which we have to deal in engineering practice. We will first define saturated or dry steam.

Saturated Steam

Saturated or dry steam is steam which is in contact with the liquid from which it has been evaporated, and is at the same temperature as that liquid. It holds no moisture in suppension, but being at the same temperature as the liquid, will liquefy under a small reduction of temperature. It is also called saturated steam because it is at its maximum density for the corresponding temperature.

Wet Steam

Wet steam is steam that holds in suspension a certain amount of moisture. The effect of this is to lower the total heat of a given quantity of the mixture of steam and water in proportion to the dryness fraction. For instance, if the mixture was 90 per cent. steam and 10 per cent. water, the total heat would be less by the following amount. If the total heat of dry steam at atmospheric pressure is 1146, this being made up of S plus H, then the total heat of steam with 10 per cent. moisture would be only S plus .9H. The dryness fraction would be .9 or 9/10. The total heat would then be 180 plus .9x966, which would be 1049.4, instead of 1146 with dry steam.

Superheated steam is steam which is not in contact with the water from which it has been evaporated, and is at a higher temperature than that corresponding to its pressure. If, for instance, we had atmospheric pressure steam, saturated, its temperature would be 212 degrees. If we had steam at the same pressure, but at 250 degrees temperature, we should have 38 degrees superheat in the steam.

The Use of the Steam Tables

The properties of saturated steam at different temperatures and pressures have been made up in the form of tables, which are exceedingly useful to the engineer, who has not the time to spare to work out intricate formulae whenever he has a problem to deal with. These tables are easy to use when the principles are understood. The following table shows the properties of steam from 1 pound absolute to 400 pounds absolute pressure. They are taken from Kempe's Hand Book, and are not exact, but sufficiently close for the purpose of explanation. The first column gives the pressure in pounds per square inch above a vacuum, or absolute pressure. The gauge pressure can be found by subtracting 14.7 from the pressure given. The second column gives the temperature of the steam in degrees Fahrenheit, which saturated steam should be at the corresponding pressure. If below that temperature, the steam is wet, while if above it the steam is superheated. The third column gives the total heat in steam above 32 degrees, and includes sensible heat, or is equal to (t—32) plus H. The heat in the liquid above 32 degrees is shown in the next column, and the latent heat in the fifth column. The sum of the fourth and fifth column is equal to the third column, or the fourth column is equal to S and the fifth column to H, while the third is the sum of S plus H. Remember that sensible heat is always reckoned from 32 degrees as a starting point. The sixth column gives the density of the steam, or the weight of a cubic foot in pounds, at the given temperature and pressure. The lower the pressure the less the density, or in other words, the greater volume occupied by one pound of the gas. The volume of steam at atmospheric pressure is about 1600 times that of the water from which it is evaporated, but one pound of water will make exactly one pound of steam. As the pressure increases the volume decreases, and density increases. The total heat increases, but the latent heat decreases, and the sensible heat increases. This table also gives the factor of evaporation. This factor of evaporation is something that should be understood by the engineer, especially if he is ever going to make tests.

The quantity of heat units required to evaporate one pound of water into one pound of steam at atmospheric pressure is 966.6. The total heat in the

TABLE I. PROPERTIES OF SATURATED STEAM (APPROXIMATE).

Pressure in Pounds per Sq. In. above Vacuum. (P.)	Temperature in Degrees Fahrenheit.	Total Heat in Heat Units from Water at 32°. (H.)	Heat in Liquid from 32° in Units.	Heat of Vaporisation, or Latent Heat in Heat Units.	Density or Weight of Cubic Foot in Pounds.	Volume of One Pound in Cubic Feet. (V.)	Factor of Equivalent Evaporation at 212°.	Total Pressure above Vacuum.
1	101·99	1113·1	70·0	1043·0	·00304	329·3	·9661	1
2	126·27	1120·5	94·4	1026·1	·00582	171·7	·9738	2
3	141·62	1125·1	109·8	1015·3	·00853	117·3	·9786	3
4	153·09	1128·6	121·4	1007·2	·01117	89·51	·9822	4
5	162·34	1131·5	130·7	1000·8	·01378	72·59	·9852	5
6	170·14	1133·8	138·6	995·2	·01635	61·16	·9876	6
7	176·90	1135·9	145·4	990·5	·01890	52·92	·9897	7
8	182·92	1137·7	151·5	986·2	·02142	46·68	·9916	8
9	188·33	1139·4	156·9	982·5	·02393	41·79	·9934	9
10	193·25	1140·9	161·9	979·0	·02642	37·85	·9949	10
14·72	212·00	1146·6	180·0	966·6	·03798	26·33	1·0000	**14·72**
15	213·03	1146·9	181·8	965·1	·03867	25·86	1·0003	15
20	227·95	1151·5	196·9	954·6	·05068	19·74	1·0051	20
25	240·04	1155·1	209·1	946·0	·06246	16·01	1·0099	25
30	250·27	1158·3	219·4	938·9	·07413	13·49	1·0129	30
35	259·19	1161·0	228·4	932·6	·08567	11·67	1·0157	35
40	267·13	1163·4	236·4	927·0	·09728	10·28	1·0182	40
45	274·29	1165·6	243·6	922·0	·1085	9·217	1·0205	45
50	280·85	1167·6	250·2	917·4	·1198	8·347	1·0225	50
55	286·89	1169·4	256·3	913·1	·1310	7·631	1·0245	55
60	292·51	1171·2	261·9	909·3	·1422	7·032	1·0263	60
65	297·77	1172·7	267·2	905·5	·1533	6·525	1·0280	65
70	302·71	1174·3	272·2	902·1	·1643	6·086	1·0295	70
75	307·38	1175·7	276·9	898·8	·1753	5·703	1·0309	75
80	311·80	1177·0	281·4	895·6	·1863	5·368	1·0323	80
85	316·02	1178·3	285·8	892·5	·1972	5·071	1·0337	85
90	320·04	1179·6	290·0	889·6	·2081	4·806	1·0350	90
95	323·89	1180·7	294·0	886·7	·2189	4·568	1·0362	95
100	327·58	1181·9	297·9	884·0	·2297	4·353	1·0374	100
105	331·13	1182·9	301·6	881·3	·2405	4·158	1·0385	105
110	334·56	1184·0	305·2	878·8	·2513	3·980	1·0396	110
115	337·86	1185·0	308·7	876·3	·2619	3·818	1·0406	115
120	341·05	1186·0	312·0	874·0	·2726	3·668	1·0416	120
125	344·13	1186·9	315·2	871·7	·2833	3·530	1·0426	125
130	347·12	1187·8	318·4	869·4	·2939	3·403	1·0435	130
140	352·85	1189·5	324·4	865·1	·3152	3·173	1·0453	140
150	358·26	1191·2	330·0	861·2	·3362	2·974	1·0470	150
160	363·40	1192·8	335·4	857·4	·3571	2·800	1·0486	160
170	368·29	1194·3	340·5	853·8	·3781	2·645	1·0502	170
180	372·97	1196·7	345·4	850·3	·3990	2·506	1·0517	180
190	377·44	1197·1	350·1	847·0	·4198	2·382	1·0531	190
200	381·73	1198·4	354·6	843·8	·4405	2·270	1·0545	200
225	391·79	1201·4	365·1	836·3	·4921	2·032	1·0576	225
250	400·99	1204·2	374·7	829·5	·5432	1·841	1·0605	250
275	409·50	1206·8	383·6	823·2	·5942	1·683	1·0632	275
300	417·42	1209·3	391·9	817·4	·6447	1·551	1·0657	300
325	424·82	1211·5	399·6	811·9	·6949	1·439	1·0680	325
350	431·90	1213·7	406·9	806·8	·7452	1·342	1·0703	350
375	438·40	1215·7	414·2	801·5	·7949	1·258	1·0724	375
400	445·15	1217·7	421·4	796·3	·8446	1·184	1·0745	400

steam above 32 is 1146.6 B.T.U. If we take steam at 50 lbs. per square inch the total heat will be 1172.7 B. T. U. Then the ratio of the total heat of steam at atmospheric pressure to the total heat of steam at 65 absolute pressure will be 1172.7 divided by 1146.6, which is 1.02. This figure will be the factor of evaporation, and the way it is used is this. Suppose that 10 lbs. of steam had been evaporated from water at 32 degrees into steam at 50 lbs. per square inch, or 65 lbs. absolute. We wish to find how this compares to the amount that would have been evaporated into steam at atmospheric pressure from the same temperature. The factor of evaporation is used as a multiplier, and we have 10 x 1.02=10.2 lbs. This is an example of the factor of evaporation at 212 degrees, as stated at the head of the table. However, in actual practice, we do not have water at 32 degrees, or any other definite temperature. Therefore, all evaporation performances are based on the evaporation of water from 212 degrees into steam at 212 degrees, and all boiler performances are reduced to that equivalent. Suppose now we had a boiler, which, under a test, had evaporated 10,000 pounds of water from 180 degrees into steam at 145 lbs. gauge pressure, and we wished to compare this performance with the evaporation of the same quantity of water from and at 212 degrees, in order to get the boiler horsepower. We would first find the factor of evaporation. The absolute pressure will be 160 pounds, and the temperature corresponding to this will be 363.4 degrees. The total heat is 1192.8 and the latent heat is 857.4. What we are interested in is the total heat in the steam above 32. As the feed water was at 180 to begin with, the total heat we have added will be 1192.8—148=1044.8. By taking the heat in the liquid above 32, which is 335.4, and subtracting 148 we get 187.4 and this added to the latent heat, 857.4, gives 1044.8 the same as before. That means that the total heat added per pound of water is more than would be required to evaporate it from and at 212, in the proportion of 966.6: 1044.8, which is 1.08. This will be the factor of equivalent evaporation, or as usually called, the factor of evaporation. The equivalent evaporation from and at 212 is then 10000 x 1.08, which gives 10800.

Suppose now that we had the same water evaporated from feed water at 210 into steam at 50 lbs. gauge pressure, or 65 lbs. absolute. The total heat in the steam is 1172.7 and the heat added will be 994.7. The factor of evaporation in this case would be 966.6:994.7 or 1.02, or 10200 lbs. would be the equivalent evaporation. Now suppose that we had been feeding the boilers through an economizer that raised the temperature to 260 degrees before the water entered the boiler, and that the steam was at 145 lbs. gauge pressure. The total heat would be 1192.8, and the total heat added would be 1192.8—288= 964.8. The factor of evaporation would now be 966.6:964.8=.998. That means that the amount of water that would have been evaporated from and at 212 would have been only 9980 lbs. The thing to remember is that the latent heat at 212, or a better way to put it, the heat of vaporization at atmospheric pressure, must be divided into the heat added at the temperature and latent heat of the steam which is to be compared, less the number of degrees above 32 that the feed water is at. To put it into an easy formula let H equal the total heat of the steam above 32, and the temperature of the feed water.

$$\frac{H-(t-32)}{966.6}=\text{Factor of evaporation}$$

$$\frac{1192.8-(260-32)}{966.6}=\frac{1192.8-228}{966.6}$$

$$\frac{964.8}{966.6}=.998$$

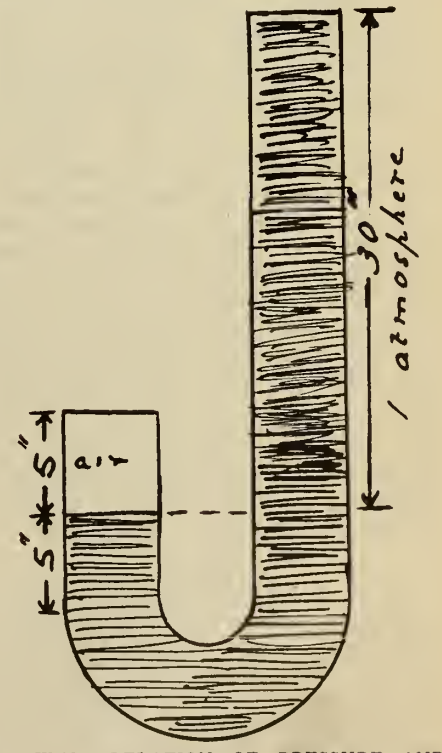
Having now got an understanding of what steam is, and the amount of energy it contains in the form of heat units, we are in a better position to study its use in the forms we are acquainted with. In order to do this we shall have to go back a little bit, and make acquaintance with some ancient laws on the behavior of gases.

Steam follows very closely the law of gases as propounded by Boyle, although not altogether so. This law is that pressure varies inversely as the volume, and the product of the pressure and volume of a gas that is expanding will always be constant. We will examine this a bit more thoroughly so that it becomes clear to the student.

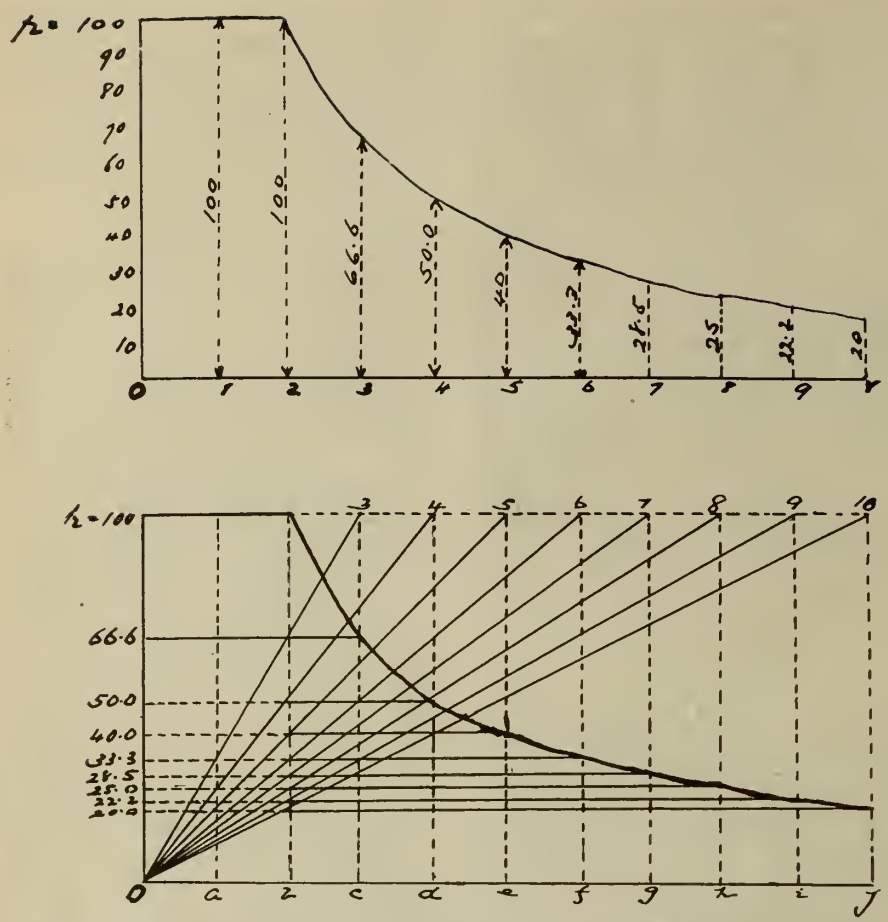
If we take a bent tube, the short leg of which is 10 inches long and the long leg 35 inches long, and close the top of the short leg with a plug, leaving the top of the long leg open, we shall have a pressure in the tube due to the atmosphere, or say 15 lbs. approximately. If now we take a quantity of mercury, and fill the long leg until the mercury stands just 30 inches above that in the short leg, we shall have exactly 5 inches of mercury in the short leg. But as we have a column of mercury 30 inches above the level of the mercury in the short tube, we have the equivalent of 15 lbs. pressure in addition to the pressure due to the atmosphere that was already there. Further, the air contained in the short leg of the tube has been compressed into just half its former volume. Therefore, if the first pressure in the tube was 1, and the volume 1, we now have a pressure of 2 and a volume of ½, which gives the same result when multiplied together as the first pressure and volume. This is a simple proof of Boyle's law, and one easily understood. By means of a diagram, in which the horizontal lines are measures of volume, and the vertical lines measures of pressure, the law can be very clearly shown. We shall show first the method of constructing the diagram from the calculation of the different pressures and volumes and secondly the method of constructing the diagram without any calculation.

Boyle's law is usually expressed mathematically as follows: $pv = c$. It follows then that $p = \frac{c}{v}$ and from this we can construct a curve which will show the pressure of an expanding gas at any point in the volume of its expansion.

In the following diagram let the vertical line represent pressures to a scale, and the horizontal line volumes to any convenient scale. The starting point 0 of the two lines will be the zero of pressure and volume. Divide the vertical line into 10 equal parts, and the horizontal line into the same number. Let us assume that the steam is at an absolute pressure of 100 lbs., and that after filling two spaces in the horizontal direction, it is cut off and allowed to expand. The product of pressure and volume at the point of cut off will then be 100 x 2=200. At the next division the pressure will be found by the expression $p = \frac{c}{v}$ or $p = \frac{200}{3} = 66.6$. At the 4th division it will be 50, at the 5th 40, at the 6th 33.3, at the 7th 28.5, at the 8th 25, at the 9th 22.22 and at the tenth 20. The average pressure over the whole expansion will be the sum of these different pressures divided by 10 or 68.56.



SHOWING RELATION OF PRESSURE AND VOLUME ACCORDING TO BOYLE'S LAW.



CURVES OF EXPANDING STEAM. TOP DIAGRAM IS CONSTRUCTED BY CALCULATION, AND LOWER ONE BY GRAPHIC CONSTRUCTION.

To obtain the same result graphically, first lay out the two lines representing pressure and volume. Make the divisions as before, drawing the vertical lines at each division. From the point O draw lines joining the division lines at the same height as the pressure line, or at the top of the diagram. From the point on the vertical line where the diagonal lines cut it, draw horizontal lines to each succeeding division line, as shown in the diagram. Then the height on each division line where the horizontal lines cut them, will represent pressure at that point, further, the area of each parallellogram will be equal, thus proving again the law that $pv=c$.

The actual behaviour of steam expanding in an engine is not quite in accordance with these laws, as we have said before, but we cannot enter into this question at this stage of the study of steam. The behaviour of steam expanding in an engine will be taken up in future lessons, starting first with the application of these diagrams to the performance of steam in the cylinder.

The R. S. Leitch Co. have taken over the agency in Ontario of the Armstrong steam trap, made by the Armstrong Machine Works, Three Rivers, Michigan. The trap is made on the inverted submerged bucket system, a different system than any other trap on the market, it being a patented article.

Catalogues

We have received a copy of MacRae's Blue Book, which is a very comprehensive directory of manufacturers and manufactured articles. The first 300 pages are devoted to a catalogue section, which contains in condensed form the catalogues of a large number of manufacturers of various lines. This is followed by an alphabetical address section, in which over 30,000 names of manufacturers are found, while the next section is a classified material section, which covers practically every material used in industry. Other sections are a trade name index, a section devoted to data of a very varied kind, such as would be useful to the specifying engineer or the purchasing agent. Standard list prices of building material and iron and steel products form another department, and a net discount computer is included. This is certainly a very valuable volume to be on the shelf of every purchasing agent and consulting engineer. It is well and strongly bound, as a volume intended for hard use should be, and is crammed full of useful information.

H. L. Peiler, manager of the Mason Regulator Company, has just returned from a very successful business trip in the Eastern Provinces.

TAPPING SOFT METALS

In tapping soft metals such as aluminum, there is quite often some difficulty in starting the thread, as the tap will at first either ream out the hole in a partial manner or strip the thread after it is started.

Both these dangers can be avoided, and perhaps the simplest method of all is to make an accurately threaded guide block about the same depth as an ordinary nut.

By placing this guide block in correct position over the hole to be tapped, no trouble will be experienced as the tap must then travel through the soft metal at a predetermined rate. Of course the guide block must be clamped to the work. It is essential that the block be fastened, and another point to be watched is the use of a good lubricant.

Whenever dealing with soft metals, do not rush the job. Humor it, for owing to the weakness of the metal it is likely to break away if too much force is used. Even copper can be stripped if two much force is adopted. If cutting threads on the lathe the danger is not so great but even there it is necessary to use the best of care. Above all see that the cutting tools are sharp. If you don't the results will be far from perfect.

Some recent tests to determine the proper amount of air required for special thermit welding gasoline and compressed air preheaters showed that 25 pounds per square inch seems to be a practical minimum. At this pressure, a single burner preheater will require approximately 25 cubic feet of free air per minute and a double burner preheater approximately 50 cubic feet. For very large welds, where the walls of the molds are thick and the preheater gates longer than usual, a pressure of 40 pounds per square inch would be advisable. This would require approximately 35 cubic feet of free air per minute for a single burner and 70 cubic feet of free per minute for a double burner.

GOOD WORK OF RECIPROCATOR

The splendid performance of the S.S. Kandahar owned by Ellerman & Bucknell has recently attracted considerable attention.

This vessel is of 10,750 D.W. tonnage, equipped with triple expansion, engines, H.P. 25½ inches, M.P. 43½ iches, L.P. 76 inches, stroke 51 inches, developing 3,200 I.H.P. at a speed of 12 knots. It is fitted with three single end Scotch boilers with Howden forced draft, and with fire tube superheaters delivering 200 deg. at the main engine throttle. It burns about 42½ tons of coal per 24 hours or about 1.24 pounds of coal per I.H.P. for all purposes.

This vessel has been operating since 1913.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

DUPLEX PUMP

Question.—What is the cause of piston on duplex pump having a longer stroke one side than the other? Also state cause of pounding in pipes running to tank when pumping?

Answer:—

The uneven stroke on the duplex pump is usually the result of defective valves or piston packing on the side which takes the longer stroke. The steam valves being worked from opposite sides of the pump, the lever on the side taking the long stroke moves the steam valve on the other side before that piston has completed its stroke. It may also be caused by too much lost motion on the spindle of the valve on the side taking the short stroke. The reason of the pounding in the pipes may also be the uneven strokes causing the water to be delivered in jerks instead of regularly. An air vessel on the discharge pipe would cure this trouble.

* * *

MARINE ENGINE

Question.—We are setting up a marine engine to do stationary work, one that has been used in a steamer. She is 15 x 30 x 22, has a condenser, a circulating pump and a pump on the engine to pump the condensed water to the hot well. We would like to do away with the condenser, that would do away with the hot well pump of the engine and the circulating pump, as we have a limited floor space.

We have a good feed water supply and if we used the exhaust steam from this engine in feed water heaters would we get as much power as we would have obtained had we used the condenser?

If it would not be too much bother would like you to drop me a line as soon as possible in answer to this question.

Answer.—I note that you are intending to set up a marine engine for stationary work, and that you suggest doing away with the condenser. You cannot hope to obtain anything like as much power without the condenser as with it, and furthermore your coal consumption will be much higher. I would advise you unless you want the exhaust steam for heating purposes to install a condenser. You did not say whether it is a jet or surface condenser. For stationary purposes where you do not require the condensate for feed water purposes you could install a jet condenser which would take up less space than a surface condenser with its air and circulation pump. To run an engine with atmospheric exhaust will cost you from 15 to 20 per cent. more in fuel for the same power, or give you 15 to 20 per cent. less power with the same fuel. The feed water heater would occupy almost as much floor space as the jet condenser, and the most you can save from heating feed water would be 1% for every 11 degrees the water is heated. If you raised the feed from 60 to 200, or 140 degrees, the saving would be only about 12%. With a 25 inch vacuum you would have the feed water in the hot well at 125 degrees, so you would only be losing about 7% of the heating, against a gain of 20% by condensing, giving you a net gain of 13% by condensing.

* * *

GAUGE GLASSES

Question.—Is there a law about having guards on gauge glasses?

Answer.—There is no law as far as we are aware compelling glasses to be protected; however it is a very simple matter for any engineer who desires protection, to fit these guards on the gauge mounting. A half round sheet of tin with a slot the length of the glass so that the water can be seen, is a good and simple arrangement, or else wire glass guards can be purchased from almost any engineering supply house.

* * *

OVERHEATED PLATE

Question:—How can I tell whether a boiler plate has been overheated? I heard some engineers talking about boilers being overheated. I want to know what they mean. I look after a heating boiler 2 pounds per square inch?

Answer:—If from any cause, such as scale, oil, or grease getting on the water surface of the plate, its heat conductivity is impaired, then instead of the heat being conducted through the plate, it will be absorbed by it. This causes the plate to be raised in temperature, possibly to a red heat, and in this state its ductility or flexibility is so much increased that it cannot maintain its shape against the internal pressure. This will result in a bulge in the plate, and according to the depth of the bulge the metal will be drawn out or made thinner. This effect may be sufficient to cause rupture. When the plate gives, the scale will be cracked away, allowing the water to reach the plate and cool it. This may occur sufficiently early to prevent the bulge assuming large dimensions. In other cases the heating may be confined to a small area, when a deep blister will be formed, and the plate drawn down thin enough to rupture. Be careful to keep the boiler clean and then you will not have the unpleasant practical lesson of what overheating means.

* * *

TESTING FOR ACID

Question:—How can I test boiler feed for acid and for alkalinity?

Answer:—The usual method is to use litmus paper, which will turn pink if water is acid, and yellow if alkaline. A better test is to use a few drops of methyl orange, which turns yellow if the water is alkaline, or a decided pink if acid. Phenolphthalein added to the water will make it a cloudy white if acid, and magenta if alkaline.

NEW INDUSTRY AT PORT ARTHUR

In a large advertisement appearing in a recent edition of a Port Arthur paper, there is an announcement of the Port Arthur Shipbuilding Co., in which is recounted the falling off in the shipbuilding industry. The announcement goes on to state:

"Anticipating this condition of affairs, we have commenced the construction of pulp and paper machinery, and compressed air mine shovels, which work will, we hope, take up the slack caused by the falling off in shipbuilding. We have, however, in this new line, to go into competition with established manufacturers of long experience in this class of work. To succeed will mean not only continued prosperity for us, but the continuation of our quota of the prosperity of our city and the steady employment of the men who comprise our organization. Such success is what we are striving to attain for 1921, and we ask each and every one of our employees to unite with us in this purpose for the good of all concerned, and the welfare of the city in which we live. Of the citizens of Port Arthur, we ask a continuation of the co-operation and goodwill that they have given us in the past."

POWER HOUSE

Member of the Audit Bureau of Circulation

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Not Alone Here

WHILE we know that the average boiler performance in this country and the United States is very low in point of efficiency, it is somewhat of a negative satisfaction to know that we are not alone in this defect. It is a negative satisfaction, because one does not like to hear of inefficiency in any branch of engineering, or in any country. Inefficiency in one country while it may help another country in a way, is yet a detriment, as it is when concerned with the burning of fuel a loss to the world. These remarks are occasioned by the perusal of an article in an English technical journal deprecating the low standard reached in the combustion of fuel under boilers generally, and the wide discrepancy between the best practice and the worst. There is a range of 100 per cent. in a number of tests made between the highest and the lowest. There should be no possibility in these days for any such variation in performance. It is quite possible for the average hand-fired boiler plant to reach an efficiency of 70 per cent., but there are a very very few that ever do it. The mere installation of mechanical firing equipment is not a guarantee of improved performance, because a mechanical equipment not properly looked after and maintained can be just as much lacking in efficiency as any hand-fired installation. The maintaining of a reasonable degree of good performance rests in the final analysis on the operating engineer, and it is strictly up to him to get the best results possible with the equipment he has. If every operating engineer sets his mind on getting better results this year than last, the end of 1921 will show a better average efficiency for the whole country. Remember that in a factory where heating is required for a large part of the year, and steam is required for industrial purposes, a well operated and efficiently run steam plant can hold its own against any competition that can be brought against it.

Saving the Oil

SECRETARY DANIELS, of the U.S. Navy, has been promulgating his views on the fuel question, and it is his opinion that oil fuel should be kept entirely for marine use. Coal and water power should be used exclusively on shore. Furthermore, he thinks that all the coal and all the water power should be nationalised. Judging from the results of the nationalisation of the railroads in the States during the war, one would not expect much enthusiastic agreement with this proposition.

We are of the opinion that oil fuel for boilers is not a method of conservation. There is as much room for waste and inefficiency in burning oil under boilers as in burning coal. The logical place for the burning of oil is in the internal combustion engine, where the crude oil can be burned with an expenditure of less than half a pound of oil per brake horsepower. Of course, in high speed passenger and naval vessels, there is a legitimate use for oil fuel, but in stationary work, the development should be more towards the utilization of the low grade coals and lignites, which afford a huge reserve. Work is being done along these lines, and it is to the results of these experiments that we must eventually look for a cheap fuel supply.

Editorial Briefs

With stores shouting half-price sales and New York funds dangling around 18 per cent., a person has to have a pretty fair education to reckon what his week's pay is really worth.

Doctors in Paris believe that the skin may be so developed that it may perform the function of eyes. Thus will preference be given to the man who sprouts an eye in the back of his neck when a foreman is wanted for a gang of day workers.

The way in which American settlers are coming to this country with their effects and their cash and the number of American firms already established here and coming over in 1921 is evidence that they have a lot of real dollars and cents faith in the future of this country. Were there any doubt in the matter, these shrewd people would not be staking millions of dollars in property and building here.

The death of Horace E. Dodge following, within a few months the passing of his brother John F., removes from the mechanical world two brothers who started in a small way, faced the vicissitudes of business and conquered. The father of these boys was the owner of a small machine shop, in which the lads learned their trade and undoubtedly learned it well. They made typesetting machines, then bicycles. Following this they turned to automobile parts and then to the finished article, until to-day their plant covers over 100 acres of floor space.

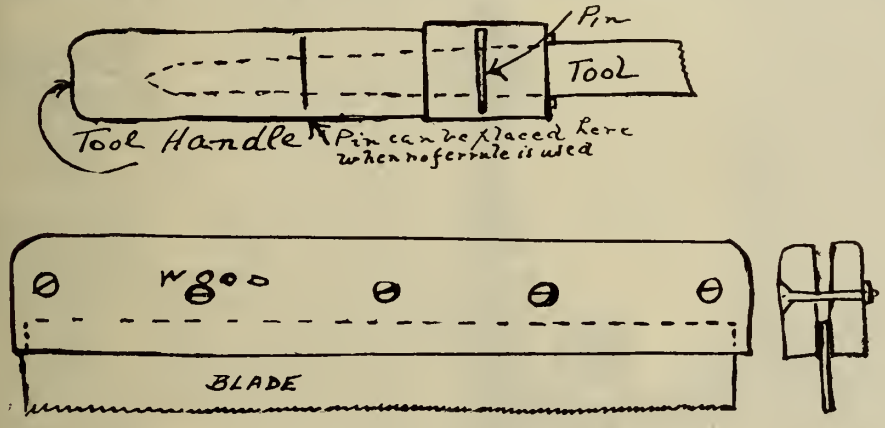
The Operators' Point of View

HANDY TOOLS

When a complicated idea occurs to a man he will take a pen and paper, sit down and work it out. When the same man is put to some inconvenience for the want of some minor article, he is apt as not to do some cussing and endeavor to do without the article missing. Perhaps if he had used his brains to think a few moments he could have solved his difficulty by using a makeshift. Many a little kink used in an emergency has saved a world of trouble and lost time. Such an article is shown in the illustration. It is so plain that little explanation is required. If you wish to make some shallow cuts in iron and have no saw frame but have saw-blades or part of a saw blade, a couple of pieces of hardwood and a few ¼-inch stove bolts will help you out. The blade is simply placed between the two pieces of wood and the bolts tightened up. You will be surprised when you try the idea out to find that a very narrow grip on the saw blade will hold it so that considerable pressure can be placed on the top and the blade will not slip.

Another little kink is also shown. It is nothing more than an iron or steel pin driven through a tool handle, tool and ferrule, holes being first made through the three articles to take the pin. Such a pin being used will allow considerable hammering on the end of the wood handle with little danger of splitting it. It also prevents the possibility of losing the ferrule should it become loose. You can take a round piece of iron, sharpen one end to form the screw driving end of a screw driver, drill a hole in the other end to take the pin. Assemble it in the handle, and you have a screw driver with the blade always in the handle.

This idea is handy to use in all tools, with wood handles, that are turned when being used. JOHN THOM.



SCREW DRIVER AND HACK SAW HOLDER

KILOWATTS AND HORSEPOWER

L. A. LaRue

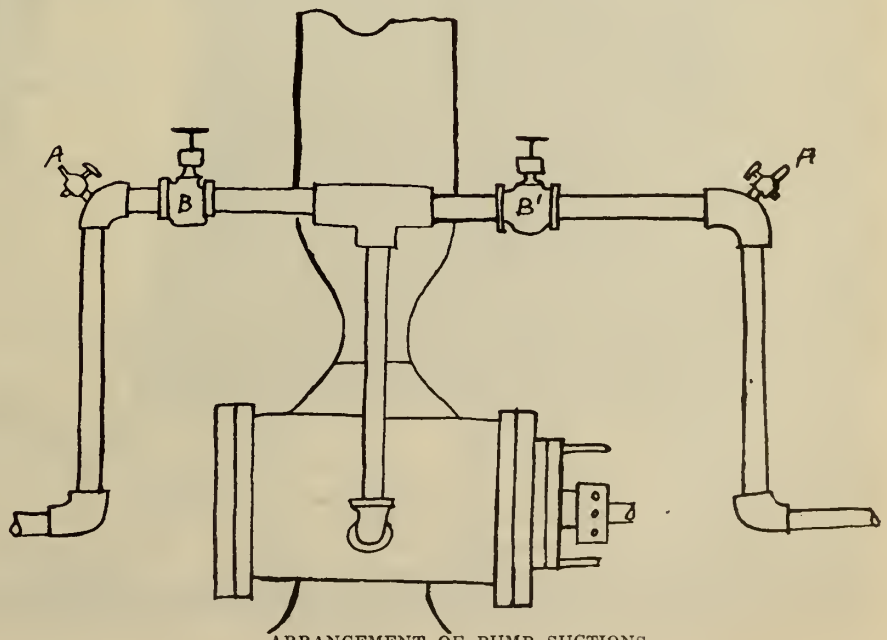
One horsepower is equal to 746 watts, hence a horsepower is equal to 0.746 kilowatts. Therefore, to reduce kilowatts to horse power, divide by 0.746, or, for an approximate result, multiply by 1 1-3. Having kilowatts, to get horsepower, multiply by 0.746, or multiply by ¾.

PREVENTING FREEZING OF SUCTION

A steam pump, in a country district, had two suction pipes connected to different sources of supply some distance from the pump. Part of these pipes ran through space not heated in the winter and it was necessary to have the particular pipe empty when water was not being drawn through it, both pipes being emptied at times. The pump itself was in a heated building and was in no danger from frost. The pump suction pipes were installed as shown. By closing either valve the water could be taken from the desired supply hole, or from both at the same time by leaving both open. When one pipe only was in use the valve on the other pipe was closed and the pet cock opened. This allowed air to enter and the pipe to empty. To prevent possibility of losing the water in the pump should the valves and air cocks be left open at the same time, the pipe was raised at the pump as shown. This made it a certainty that there would always be water in the pump. Otherwise the pump would have to be primed.

JAMES ELLETHORN.

The Canadian Tygrad Engine Co., Toronto, has awarded contract for its carburetor plant to be erected on Kingston Road at a cost of $40,000, to the Trussed Concrete Steel Co., 34 King Street West, Toronto.



ARRANGEMENT OF PUMP SUCTIONS

Lubrication and Its Importance to Industry

By A. H. NOYES

THIS is truly the age of machinery. The mechanical inventions of the past fifty years have been marvelous. Watching certain modern machines, with their giant arms, manipulating with absolute ease seemingly impossible loads, and watching still another type of modern machine performing operations delicate enough for a woman's fingers, it is almost impossible to refrain from looking for the god, sometimes the demon, who must be hiding behind the machine and working the levers.

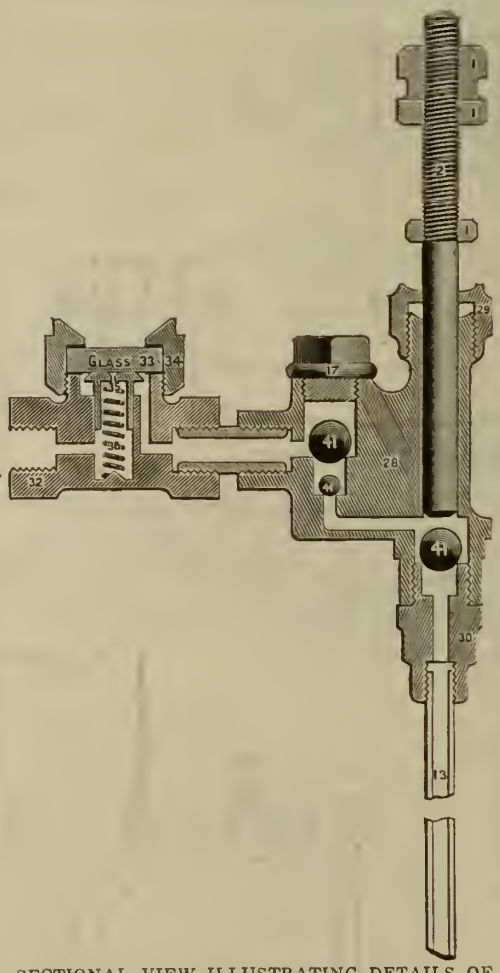
Did you ever stop to think that this intricate and often delicate machinery depends absolutely upon one thing, a thing that can not only stop every current and cog and wheel but damage the whole apparatus beyond repair? Does one person in a thousand realize that this tiny thing, which nevertheless has the life of the whole tremendous mass of machinery in its power, is a drop of oil? What irrevocable damage is caused by two metal surfaces sliding, rolling or grinding over each other, if there is no lubricating substance between.

Ever since machinery has been in existence, lubrication has been its companion. In fact, it existed even before there were machines, when it was simply a case of reducing the power necessary to push one surface over another. People did not know the word friction, did not even know what lubricant meant, but they did know that a little bit of fat or grease made the sliding a lot easier. Even today, in the island of Madeira, the natives' ox-carts have runners instead of wheels, and to assist the patient animal, the driver runs ahead with the "grease rag," with which he smears the cobble stones of the roads. From years of greasing they look like polished ebony.

It is a far call from a wooden sled sliding on cobble stones to two highly polished metal surfaces gliding over each other in a delicate machine, to the powerful piston of a great ship sliding back and forth in the cylinder pushing the whole weight of the ship before it, or the wonderful roller and ball bearings which do so much to reduce friction, and consequently the cost of motive power today. So it is a far call from the grease rag of the Madeira native to the marvelous automatic force feed lubrication of the present day's genius. If the yelling, gesturing native become a bit too tired of running back and forth with his "grease rag" it is only a little more sweat and effort from the patient ox that is at stake, no one hurt, no damage done, only a little more time wasted, and time is a drug on the market with the natives.

But when two polished metal surfaces slide over each other, unoiled, they have a fatal tendency to stick together. Then what? Bearings destroyed, cars delayed, ships at the mercy of wind and wave, time which is worth millions lost, contracts forfeited, and incalculable damage done. Lubrication, then, becomes the sine qua non of industry. This seemingly unimportant thing becomes of prime importance and must be considered from two viewpoints. The first of these is the selection of the lubricant, and the second is the continuous application of this lubricant to the bearings in the amount required.

Only a child would attempt to lubricate the highly polished bearings of an



SECTIONAL VIEW ILLUSTRATING DETAILS OF THE FEEDING MECHANISM.

astronomical instrument with graphite, or to put crude oil in the delicate movements of a watch, neither would highly refined machine oil be of great service in the bearing of a cement crusher. But between these wide limits there is an infinite number of degrees of refinement, and much of the life of a machine depends upon the selection of exactly the right lubricant.

However, the utmost care and the most expert knowledge might be exercised in selecting just the lubricant suited for a machine, and little use would it be if it never reached the bearings. A poor lubricant that reaches the spot is much better than a perfect one that stays in the oil tank. This is where the element of human frailty formerly entered. The man with the oil can was often more important than the president of the company, his mistakes would sometimes be more costly, and both the president and the oiler were liable to error. Men have such excellent "forgetteries." Add to that characteristic the universal tendency to carelessness and to "slighting the job," and you have in humanity a woefully deficient oiling machine.

Some accurate and reliable lubricating instrument had, therefore, to be devised. There were, however, certain advantages that the human oiler did have: the machine which should replace him must incorporate all of these advantages to a higher degree, and, in addition, it must not get out of order. So came into existence the force feed lubricator. For instance, the lubricator must start work as soon as the machine starts and must deliver oil in proportion to its needs. A ratchet driven pump was found to best fulfill these two conditions. The motor driven pump of course does not vary its stream of oil and the hydrostatic pump was no more successful. In the latter type the steam condenses in the condensing chamber and forces the oil drop by drop to the bearings. This is successful enough when the machine is working slowly, but when it works rapidly, so much live steam is passing into the chamber that it does not condense fast enough and therefore does not feed the required amount of oil just when the need is greatest.

Hence the ratchet driven pump, to my mind, has almost supplanted other types. It derives its power from a moving part of the machine and consequently stops and starts and accelerates or retards its own speed exactly with the machine. It therefore regulates its delivery in direct proportion to the needs of the machine.

Some of the pumps are fitted with worm gears. These are especially adapted to high speed steam units such as direct connected light engines and sawmill steam feeds of the reversible rotary type. But the "man with the oil can" was not affected by heat or cold, and if working in flying dust he might rub his inflamed eyes, but he still kept on oiling. The best modern force feed lubricators have heaters incorporated in them and they are more oblivious to cold than any man. They do not solidify in winter, therefore, and they do not over-

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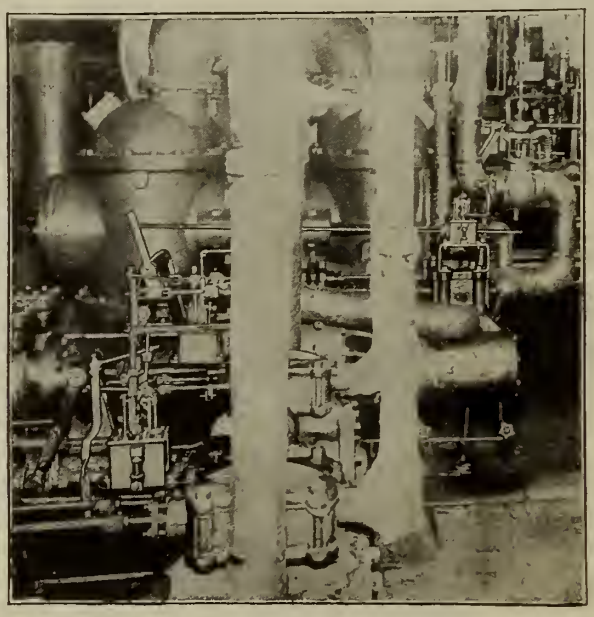
feed in summer. The only way to avoid dust clogging was to place the oil in a solid box free from the working parts. This principle, as soon as discovered, was applied in the most advanced type of pumps. In this way it was made absolutely impossible for flying dust and grit to get into the oil and be carried to the bearings.

Although accuracy and reliability of action were probably the chief considerations in the mind of the originator of these pumps, yet they have been found to effect a very great economy in oil, as well as in man power. Some of the pumps are credited with saving from 50 per cent. to 80 per cent. of oil—a not insignificant matter in these days; and



THE LUBRICATOR IN ACTION.

The working parts should be as simple as possible and they must be easily reached and repaired. One model has a one-piece valve which eliminates practically all troubles, for it is obviously impossible for a solid casting to get out of order. All the working parts of this model are on the outside of the oil reservoir, which probably accounts for the absence of repair bills for continuous service.

The sight feed is one of the latest and most important devices added to the force feed lubricators. The sight feed leaves the action of the lubricator visible so that an interruption in the flow of the oil is immediately detected. By its means, also, the engineer can see exactly the quantity of oil going to the various bearings.

The lubricators also have several chambers in the oil reservoirs, as many as required, in fact, and can therefore deliver different oils to different bearings. This is necessary to the life of any machine. Pumps of all sizes are in use, from the very small one-feed pump to the one holding several gallons of oil and delivering by forty feeds. The larger pumps or, as they may be called, pump systems are designed for the location they are to occupy. The lubrication of an entire plant is thus controlled from a central point. The economic advantage of such a system is unquestionable. To such an extent is this recognized that practically all the large power plants and all marine engines are equipped with automatic force feed pumps.

the cost of the wage which would have been paid to an oiler doing the work of its forty feeds.

Recent years may have produced more marvelous and more intricate machines than the force feed lubricator, but none to my mind that have demonstrated a greater usefulness or a more perfect adaptation to the needs they were designed to serve.

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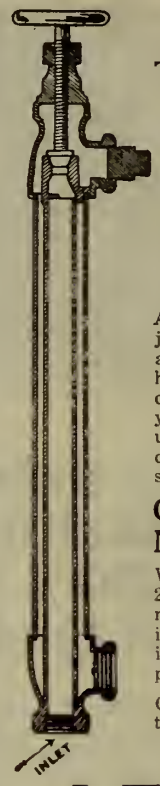

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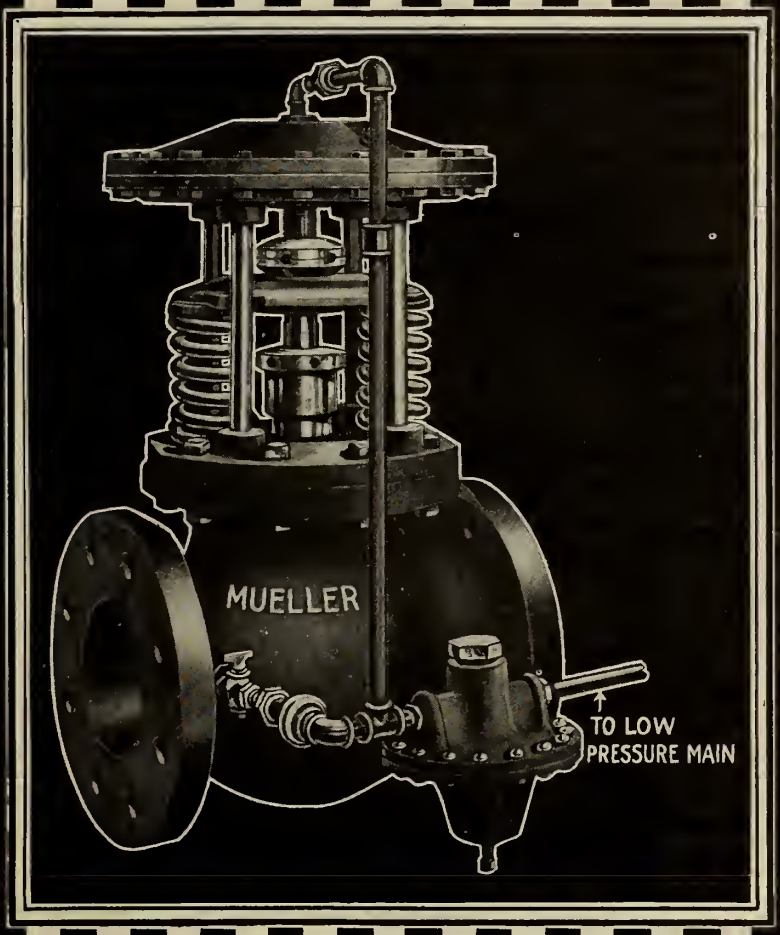

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*Reference—
W—Words.
I—Illustrations.
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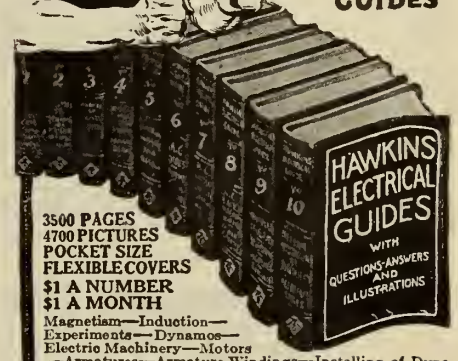

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X L C R	20		

Colored

Lion	16	Popular	13
Standard	14	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Toronto
Tin	$45 00	$50 00
Spelter	8 75	10 00
Lead	7 75	9 00
Antimony	8 25	9 00
Aluminum	35 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

MURPHY AUTOMATIC FURNACES

A Stoker to Meet Your Conditions

The type of Stoker you need is determined by the size of your boilers, fuel, load conditions and other local factors. Naturally, *one* type will not meet all these conditions but in the Riley Underfeed Stoker and Murphy Automatic Furnace you have a choice that will meet practically any condition.

For the plant with large boiler units *or with smaller units that are to be forced above rating* or where reserve capacity is essential, the Riley Underfeed Stoker meets the conditions. The moving grates—found only on the Riley—keep the fuel bed broken up and insure a mixture of air with coal that results in high capacity and efficiency.

For the plant with smaller boiler units or with *medium size boilers carrying a steady load,* the Murphy Automatic Furnace has proved its worth in thousands of installations. Operating on natural draft the original outlay is comparatively small. This furnace requires very little attention and the operator need not be so highly skilled.

The Murphy Furnace is the product of 44 years of investigation and development. With the use of poorer grades of coal in the last few years, improvements have been made to handle such fuel to the best advantage. Many of our clients report highly favorable operation with their old furnaces incorporating these improvements and used with the lower grade fuels.

Since no two plant conditions are alike, it will be to your advantage to utilize the experience of our engineers, who will gladly analyze your power plant problem and recommend the equipment best suited to your needs.

Ask for our stoker catalog H-1 for Riley Stokers and HM-1 for Murphy Furnaces

"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS.
Makers of
RILEY UNDERFEED STOKERS

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MURPHY AUTOMATIC FURNACES

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CINCINNATI CHICAGO ST. PAUL DENVER

The Findings of Two Authorities
Before and After the Advent of the

COPES SYSTEM
of
BOILER FEED REGULATION

"The advent of the flow meter brings to light the fact that the greatest variations in the amount of work which a boiler does are caused by varying the supply of feed water. To eliminate the fluctuations due to this cause, the feed water regulator at once suggests the desirability of feed water system regulated at each boiler by an automatically controlled valve capable of differential variation according to height of water and rate of steam."

Prime Movers Committee, Nat'l Elec. Light Assoc., June, 1912.

BEFORE the above was printed, the Northern Equipment Co. had foreseen the need, and had been experimenting with a continuous feed regulator which automatically lowered the boiler water level during peak and overloads, and raised it during sub-normal or no load periods. This principle of boiler feed regulation was suggested to the Northern Equipment Co. by the method commonly practiced on locomotives, which increases overload capacity, reduces fuel consumption, and saves considerable effort on the part of the fireman. In spite of the fact that the new Copes regulator was ridiculed by skeptical engineers and by other regulator manufacturers when it first appeared, many leading power station officials were using Copes Regulators by the early part of 1913 and had found that they did everything that was claimed for them. So satisfactory were the results, that the following report was issued:

"Regulators are now available which give a graduated control of the feed water and permit a variation in the water level between any two extremes that may be fixed. The height of the water in the gauge glass, when the water level remains constant, is then some indication of the rate at which the boiler is being worked. This method of feed control enables peak loads of short duration to be carried with a more uniform working of the furnace."

Power Generation Committee Report,
American Elec. Ry. Engrg. Assoc., October, 1913.

COPES

Northern Equipment Company

The World's Largest Manufacturers of Feed Water Regulators

112 W. 11th Street - - Erie, Pa.

Canadian Representatives:

ALLEN GENERAL SUPPLIES, LTD.
205 Yonge St., Toronto, Ont.

H. N. BROWN
P.O. Box 620, New Glasgow, N.S.

MASON REGULATOR & ENGINEERING CO., LTD.
153 Dagenais St. (St. Henry), Montreal, P.Q.

C. C. MOORE & COMPANY, *ENGINEERS*
618 Mutual Life Bldg., Seattle, Wash.
(Representatives in British Columbia)

W. W. HICKS & CO., 567 Banning St., Winnipeg, Canada

116

A MOST RECENT DEPARTURE

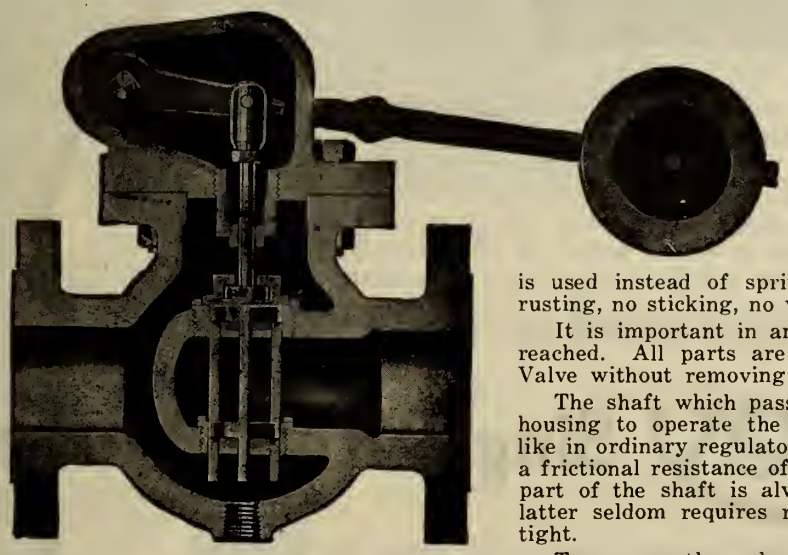
A Boiler Feed Regulator

Specifically Designed To Suit Each Boiler

THE results of a long series of tests and investigations which the Northern Equipment Co. started at the beginning of 1917 are now at the disposal of the engineering profession.

The purpose of these was to determine the actual flow through Copes Control Valves under all the various conditions which determine the characteristics of boiler feed regulation, such as normal boiler horsepower, maximum rating, method of firing, steam pressure, water pressure, and the size of the feed line. With the data now at hand, it is possible to offer a Copes Feed Water Regulator especially designed to insure maximum operating efficiency under any set of conditions peculiar to a given boiler. This can be applied to old installations as well as new ones.

Three general types of Copes Boiler Feed Valves have been carefully developed. The Northern Equipment Co. engineers will furnish a design made to meet the specific requirements governing each boiler.



The Copes Regulator Control Valve

This cross-sectional view shows the perfectly balanced Copes control valve, in which sliding spindles have been entirely eliminated. A weight is used instead of springs, giving constant force. No rusting, no sticking, no weakening with age.

It is important in any valve that parts can be easily reached. All parts are easily removed from the Copes Valve without removing the valve from the feed line.

The shaft which passes through a stuffing box in the housing to operate the valve does not slide in and out like in ordinary regulator valves, but rotates slightly with a frictional resistance of practically zero. Since the same part of the shaft is always within the stuffing box, the latter seldom requires repacking or attention to keep it tight.

To remove the valve seats, a piece of flat stock and any ordinary wrench are the only tools necessary. This, too, can be done without taking the Copes valve out of the feed line.

For complete details get our Bulletin D.

COPES

Northern Equipment Company

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(Representatives in British Columbia)

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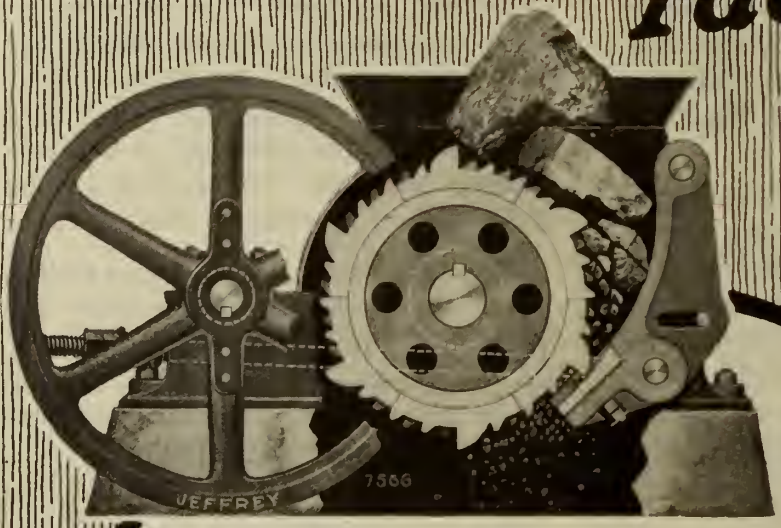
Power plant efficiency = 100% Factor of Safety = ?



PATENTED

Your plant may be functioning at top-notch speed—there may be close co-operation, scientific management, large output, quick deliveries, and everything operating at the highest efficiency, but at the very minute you may be working under a peak load, you suddenly find yourself deprived of a supply of stoker coal and your whole system goes to smash.

Your have overlooked the Factor of Safety.

A Jeffrey Single Roll Crusher

installed in your power plant means a real, lasting and dependable Factor of Safety.

It crushes run-of-mine or lump coal to stoker size in one operation and makes your plant independent of Mine, Weather and Traffic Conditions.

Write to-day for copy of Bulletin No. 141-4.

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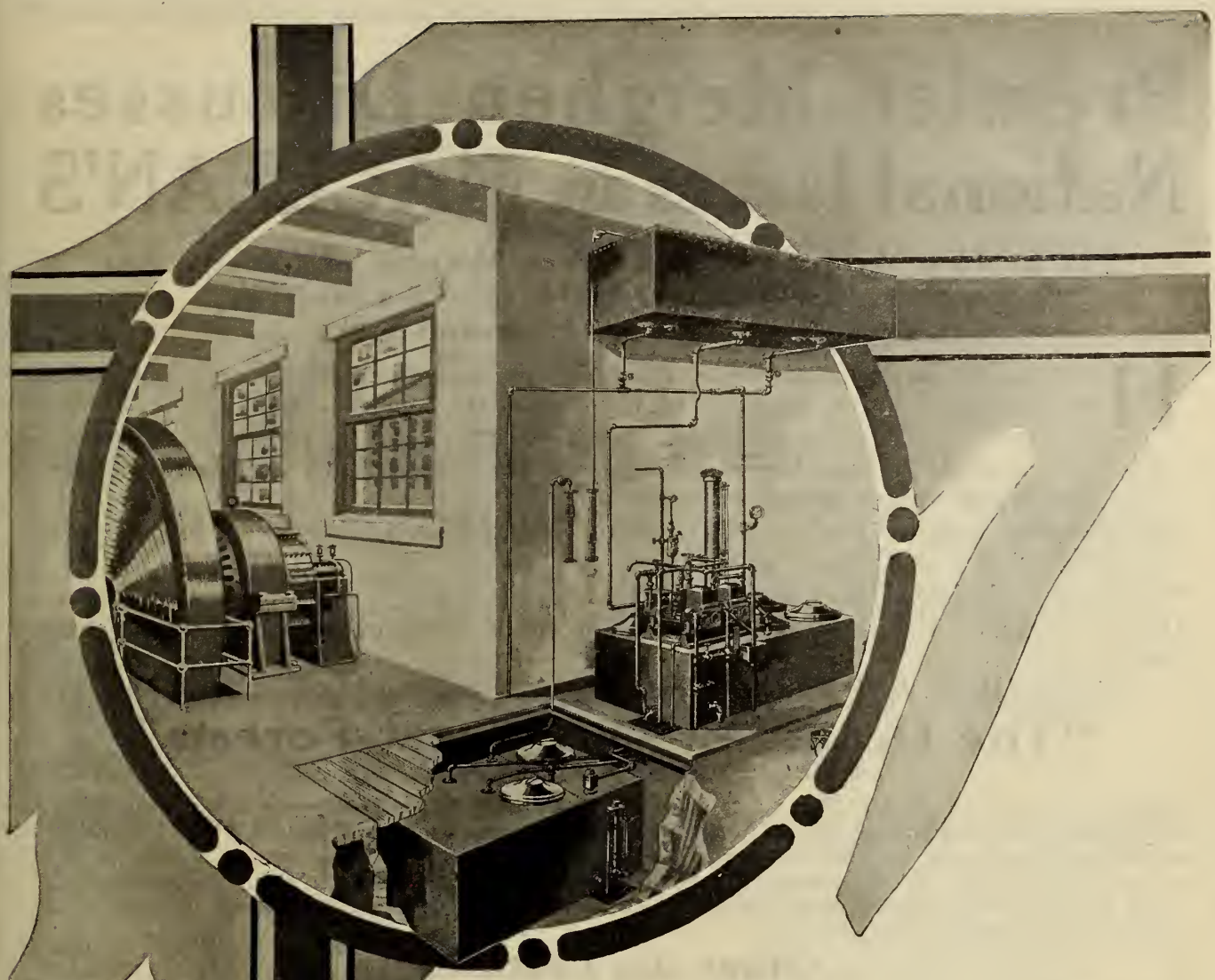
The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL



Save Fuel by Reducing Friction

Much of the friction on engines is due to irregular hand feed lubrication or using oil which is dirty and contains impurities. This increased friction necessitates the consumption of more coal to produce the required power.

Reduce this friction by installing a Bowser Stream Feed Circulating and Filtering System.

A close study of operating costs in power plants has proved conclusively that there is a reduction in friction and a saving of approximately 5 per cent. in the fuel costs where stream feed lubrication is in practice as compared with hand lubrication methods.

In a plant of only ordinary size, a year's saving in the reduced friction will pay for the installation of a Bowser Stream Feed Lubricating and Filtering System.

Write for our illustrative booklet showing our various filtration systems.

S. F. BOWSER COMPANY, LIMITED

TORONTO, CANADA

Branch Offices in Principal Cities of U. S.

Premier Meighen Discusses National Issues in MACLEAN'S

The Rt. Hon. Arthur Meighen, Prime Minister of Canada, has written for January 1st MACLEAN'S a forceful exposition of his platform and policy.

HE discusses the bi-lingual issue, the tariff, reconstruction, the growing unrest and unemployment — but he avers that the tariff is the "one great issue of our domestic politics."

"Why is it the issue?" queries Mr. Meighen. "It is the issue, I think, because the enemies of the Government cannot oppose us on any other."

Regarding the tariff, the Premier tells readers of MACLEAN'S: "We do not propose going any higher *on any single line of articles.*"

"Is Mr. Crerar hedging?" the Premier inquires.

Of Mr. Mackenzie King he says: "He can be quoted on almost every conceivable side of the tariff issue."

Articles by Mr. W. L. Mackenzie King and Mr. T. A. Crerar will follow in succeeding issues.

"The Drama of Our Great Forests"

A BIG INSTALMENT IN JANUARY 1st MACLEAN'S

This stirring story by Arthur Heming is continued in January 1st MacLean's, chock-full of wood-lore, fascinating yarns of the luring, frozen North, and amazing tales of actual adventure. The life history of the Canadian beaver, our national animal, is unfolded in a manner that surpasses fiction, as fact so often does if truly told by a masterful writer—"the beavers—those wonderful amphibious animals of the Northland that display more intelligence, perseverance, prudence and morality than many a highly civilized human being."

Other Big Features

"The Big Time Man."
By C. W. Stephens.
A romantic story of the unromantic business of making bottles.

"Money and Motion Pictures."
By John W. McKay.
A Canadian who filmed "The Miracle Man."

"The Diamond Pickers."
By Madge MacBeth.
The girl detective finds how diamonds disappear by extra-human agency.

"Foiling the 'Free Trader'."
By Kathrene and Robert Pinkerton.
A Hudson's Bay story, where the Indian outwits his white foe.

"The City of Peril."
By Arthur Stringer.
A big slice of this serial of Bolshevistic peril.

"When Toronto Grew Up"
By Col. Geo. H. Ham.
Anecdote after anecdote of the past fifty years in Toronto.

"Margot and Peter Flower."
By Mrs. "Margot" Asquith.
The commencement and course of an amazing eight years' flirtation.

Review of Reviews

Selections culled and clipped from the cream of the world's periodical literature.

"How France is Recovering"—Lovat Fraser.
"Germany Still Unrepentant"—J. Ellis Barker.
"Winston's Opinion"—Rt. Hon. Winston Churchill.
"Women Rule Films"—W. Stephens Bush.
"Wells on Mankind"—H. G. Wells.
"Bethmann-Hollweg Explains"—A. J. Toynbee.
"Jailing the Journalists"—Freeman's Journal.
"Forced Into Slang"—George Ade.
"A Simple Solution of Labor Problems"—E. S. Howe.

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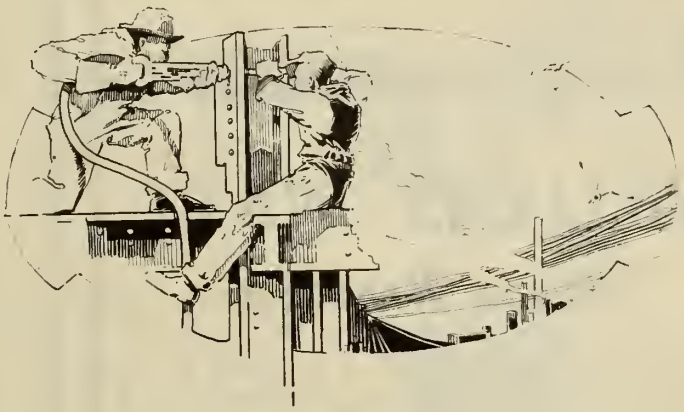

Foresight in Selecting Rubber Hose

Most buyers of rubber hose know from experience the dependability of Dominion Rubber System Hose in living up to every claim made for it.

We meet the demands of modern industrials by making over fifty types of hose to meet every condition, simple or exacting as it may be.

Dominion Rubber System Hose for Every Industrial Use

is made in various types, for liquids, oils, gas, acids, steam, suction and other uses, at all practical pressures and temperatures.

With our comprehensive catalogue before you, it is an easy matter to specify the particular hose for any requirement.

For catalogue or information, write our nearest service branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM AND ASSOCIATED COMPANIES

Our Dominion Belting, Packing and Industrial Rubber Goods are all the same High Standard as Dominion Hose.

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Quebec	London	Brandon	Lethbridge
Montreal	Kitchener	Regina	Vancouver
Ottawa	North Bay	Saskatoon	Victoria

Belting

Transmission: "Dominion," "Keewatin," "Para."

Conveyor: "Rockproof," "Canadian," "Hiheat"

Elevator: "Dominion," "Rockproof."

Agricultural: "Dominion," "Star."

Grain Elevator: "Metcalf Standard," "Grain King."

Hose

Air: "Kushion Kover," "4810 Airtite," "Star."

Steam: "Indestructible," "Rockproof," "Para."

Water: "Indestructible," "Para," "Kushion Kover," "Star."

Suction: "Para," "Star," "Trade."

Garden: "Canadian," "Dominion," "Star."

Packing

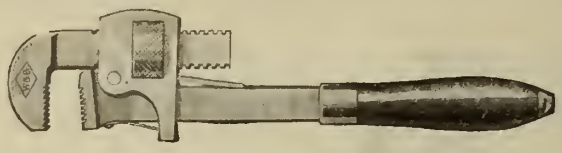
Sheet: "Join-Tite," "Star," "Importers."

Rod: "Cabestos," "Valve-Bestos," "Canadian."

Valves: "Montreal," "Commercial." "Canadian."

Miscellaneous

Mats, Matting and Flooring, Plumbers' Specialties, Rubber-Covered Rolls, Friction Tape, Splicing Compound, Dredging Sleeves, Hard Rubber Goods, Tubing, Rinex Soles, Catspaw Heels, Jar Rings, Moulded Goods.



Behind

WILLIAMS' "W&B"

Stillson Wrenches

there is nearly half a century's experience in the manufacture of superior drop-forged tools.

Made in two models—wood and steel handle—and in 8 sizes from 6 to 48 inches, with capacities from 1/8 to 5 inches. At your dealers'.

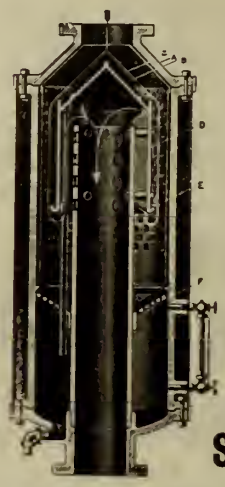
J. H. WILLIAMS & CO., LIMITED

"The Wrench People"

78 Thorold Road St. Catharines, Ontario

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY

218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited

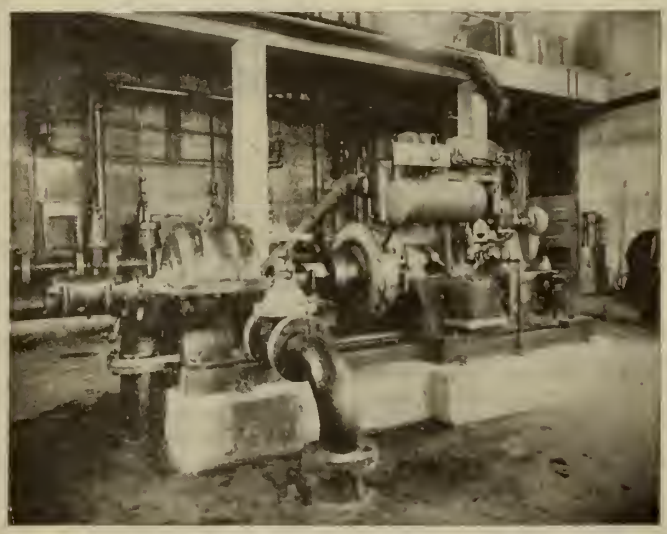
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Sterling

THE ENGINE of REFINEMENT

For the finest boats that float

The Cities of Gastonia, N.C.; Ironwood, Mich.; Lockport, Ill.; Defiance, Ohio; Toronto, Ont.; Three Rivers, St. John and Laval de Rapids, Que.; and a host of other American and Canadian cities are adopting high duty Sterling gasoline engines for continuous emergency service.



Interior pump house, Laval de Rapids, Que. Model VC 4-cylinder Sterling, 100 H.P. direct connected to turbine fire pump for standby service as a protection against breakdown.

STERLING ENGINE CO. Dept. C-4 Buffalo, N.Y.

4, 6 and 8-cylinder, 12 to 300 H.P., speeds of 400 to 1500 R.P.M., for centrifugal fire and pump electric generator drives.

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited

Sole Distributors for Canada

WEIR PUMPS

The Most Reliable For Feed and Other Duties

The boiler is the heart of the ship or power plant. Any possibility of a stoppage is exceedingly serious. Therefore it pays to use pumps whose past and present performance proves that they are to be relied upon at all times.

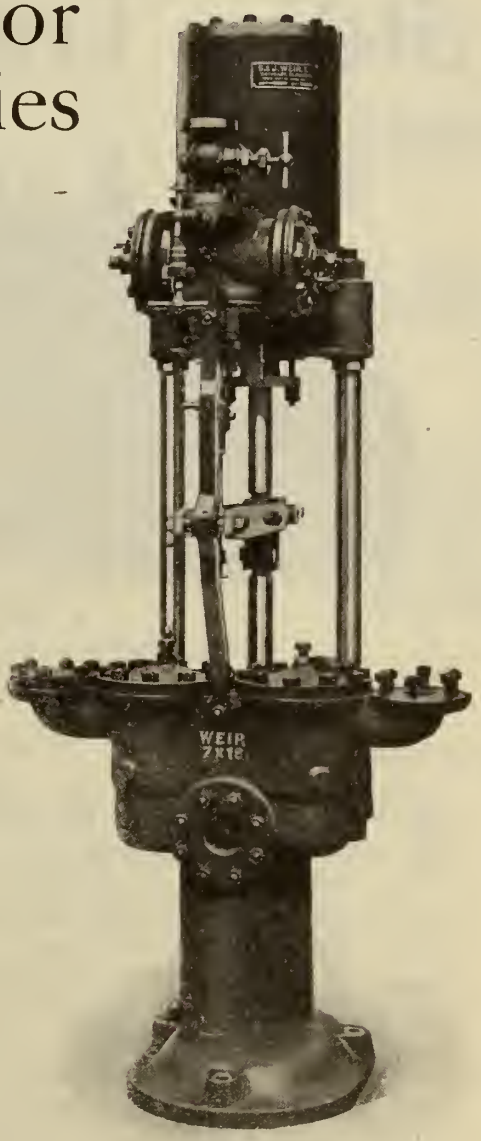
Weir Pumps are designed to work at moderate speeds. Thus they last longer and work more satisfactorily than high-speed running pumps.

When you buy a Weir pump you are sure of quick service in case new parts are required.

Overhauling and renewal is greatly facilitated by our system of interchangeable parts and the fact that we keep in stock at all times parts for our standard pumps.

Special attention is paid to the prompt dispatch of goods and the routing and shipment of all consignments. Special instructions in this regard always receive our most careful attention.

The fact that there are over 65,000 Weir Pumps in use in all parts of the world should be proof positive of the service they render.



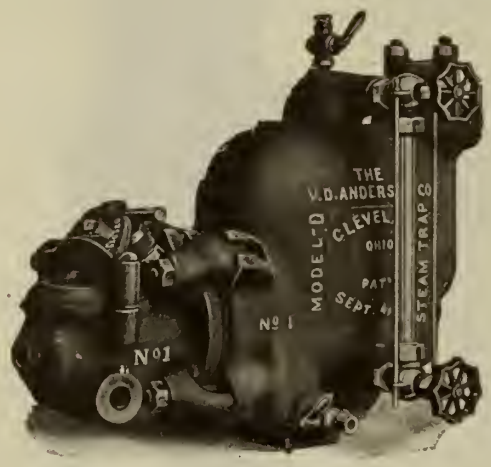
Full particulars of Weir Pumps and other auxiliaries will gladly be furnished upon request.

G. & J. Weir (Canada) Limited

SALES ENGINEERS

Peacock Brothers, Limited, Montreal

ANDERSON
Model "D"
Steam Trap



No More Condensation Worries ! !

THE shortest route to absolute freedom from expense and numerous condensation worries is to install an Anderson Model "D" Steam Trap in your steam room. Think of the carefree trap service it will give you—tight from the moment it is installed.

The Anderson, by reason of its interchangeable parts, can be used on any steam apparatus where there is condensation to handle. Its sturdy construction and simple design give complete accessibility to every part.

Write for full particulars

The V. D. Anderson Co.

1935 W. 96th St., CLEVELAND, Ohio

Emerging from the welter of unrest and uncertainty, let us face the future with an optimism and a resoluteness that will carry us forward to ever increasing success and prosperity

The L S Starrett Company
ATHOL MASSACHUSETTS

12-127

UEHLING CO. Recording Equipment

CO2
CO2 Recorder for office of Chief Engineer. Can be placed any distance from the boilers and it will trace continuous records of the changes in CO2 exactly as they occur during every second of boiler operation
is SAVING FUEL for
Number of Uehling CO2 Recorders
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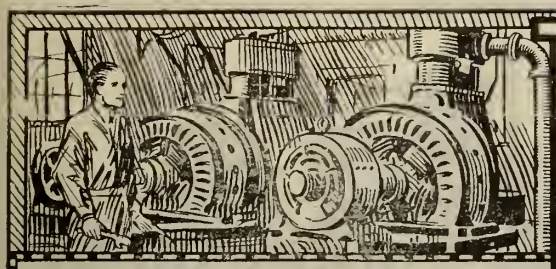
Dominion Iron & Steel Co. 14
E. I. du Pont de Nemours & Co. 16
Thos. A. Edison Laboratories 9
Ford Motor Co. 17
Standard Oil Co. 51
If it can save fuel for these and scores of other leading companies, it can save fuel for you.
The New Uehling CO2 Equipment reduces waste of fuel up the chimney by insuring correct air supply. It guides the fireman at the boiler in burning any kind of fuel, while simultaneously recording results in the chief engineer's office. It usually pays for itself in a few months, or even weeks, by savings effected.
Send for Bulletin 111
CO2 Indicator is as important to combustion economy as the water gauge glass is to safety. Mounted on the boiler front, it guides the fireman by showing the percentage of CO2 and giving warning when improper furnace conditions prevail
UEHLING
Instrument Company
COMBUSTION ENGINEERS
2008 Empire Bldg New York



MINISTRY of MUNITIONS

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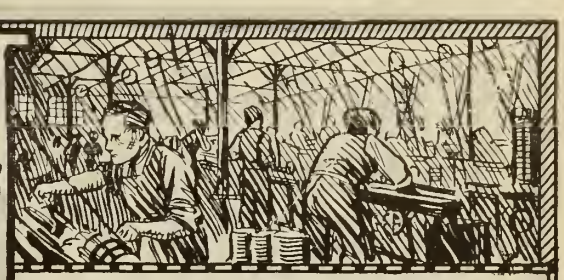

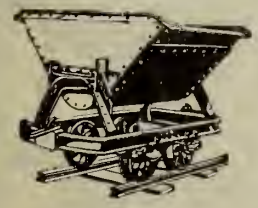

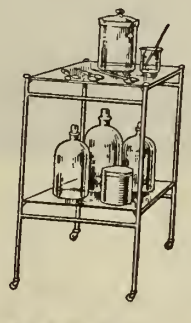

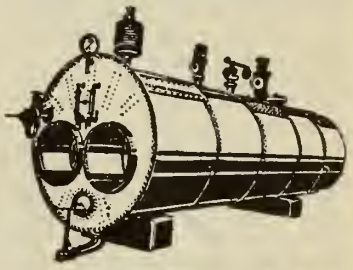

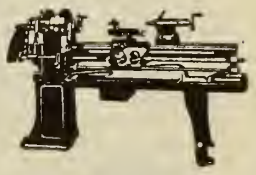

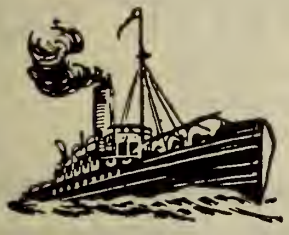

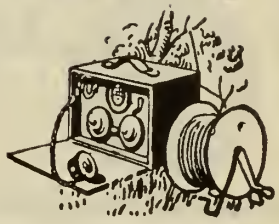

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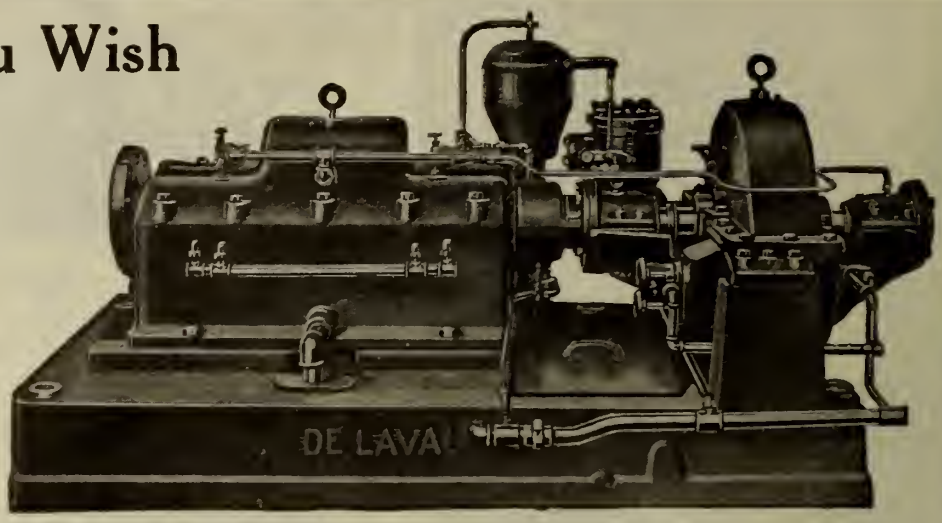

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It is simple, has few parts and is substantially built. The forced lubrication system with sight feed eliminates the oil can and the grease cup and the man who takes care of them. The hand-operated nozzle valves provide for maintaining efficiency with widely varying loads or steam pressures. The powerful, accurate governor gives close speed regulation.

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And the line is complete—a Valve for Every Service—Every one tested before leaving the factory.

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Fig. 402

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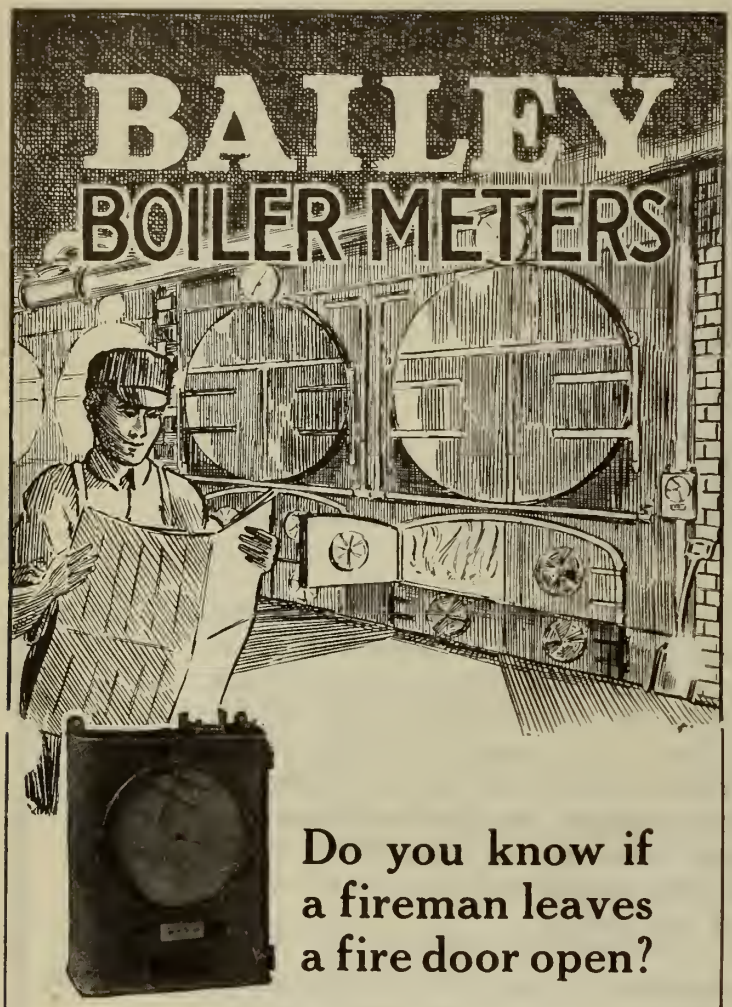

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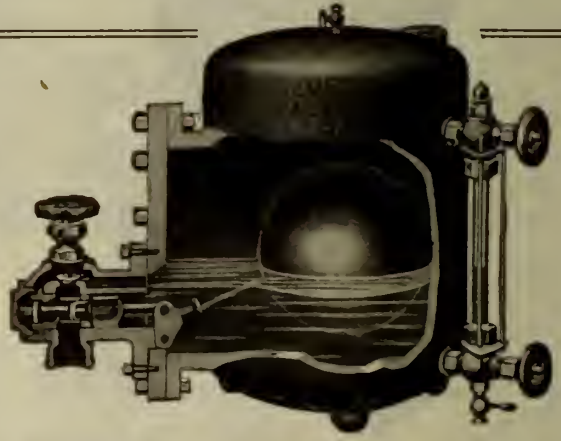

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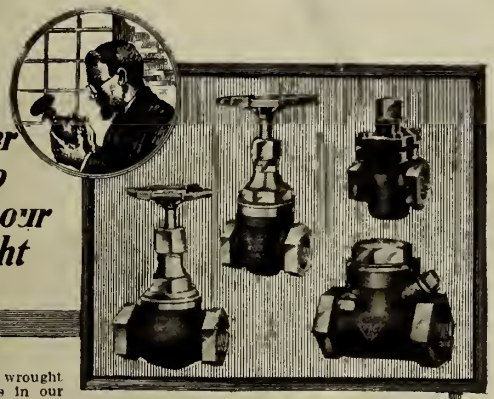

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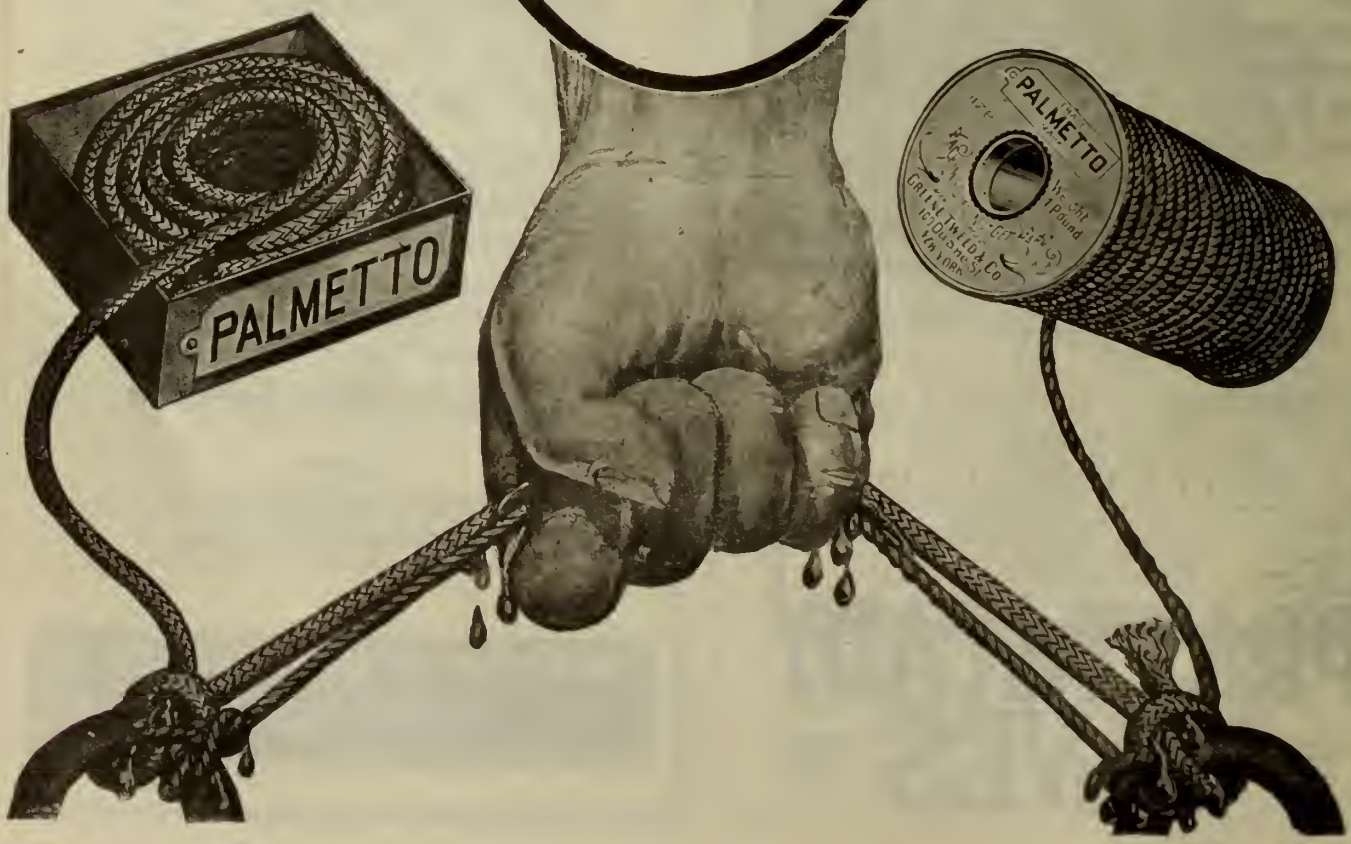

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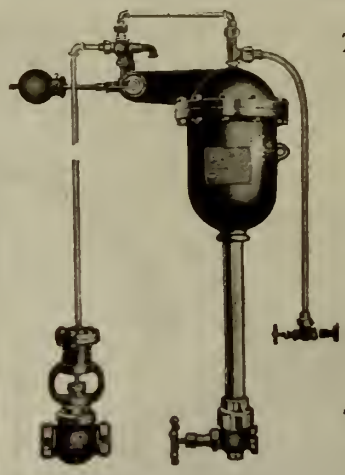

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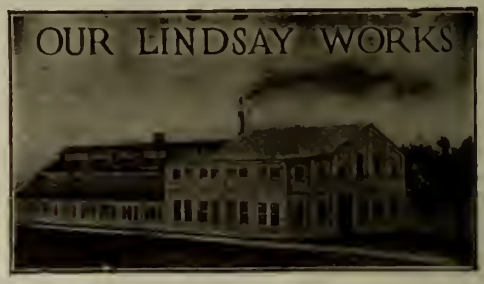

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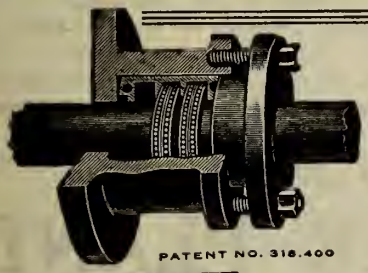

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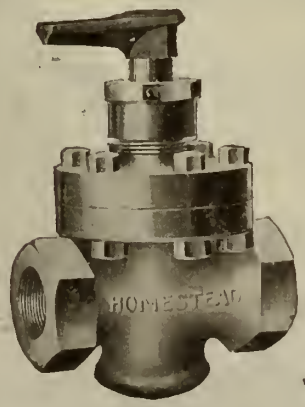

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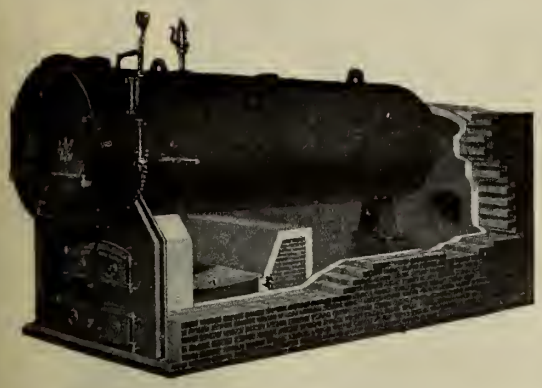

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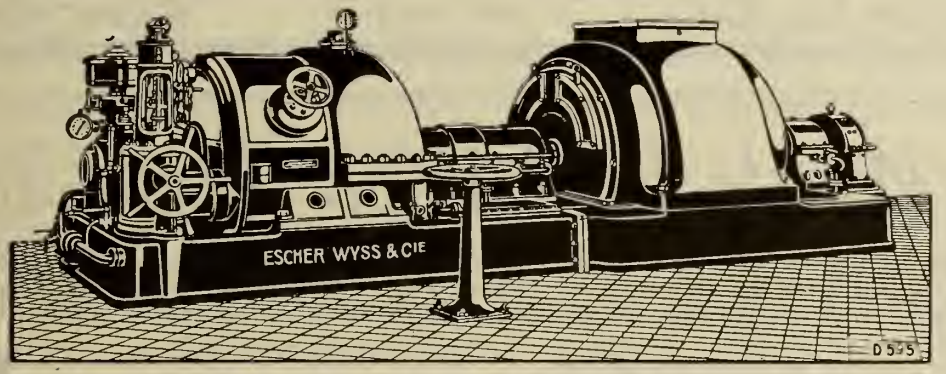

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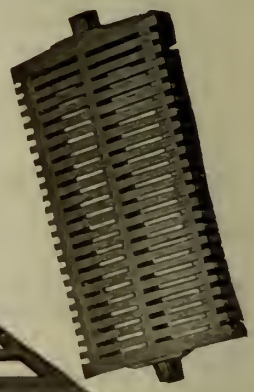

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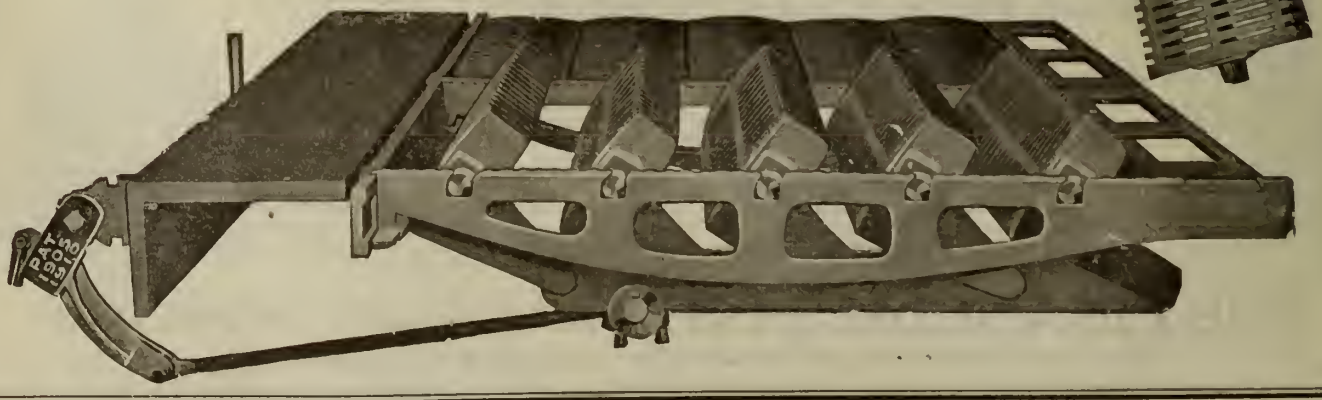

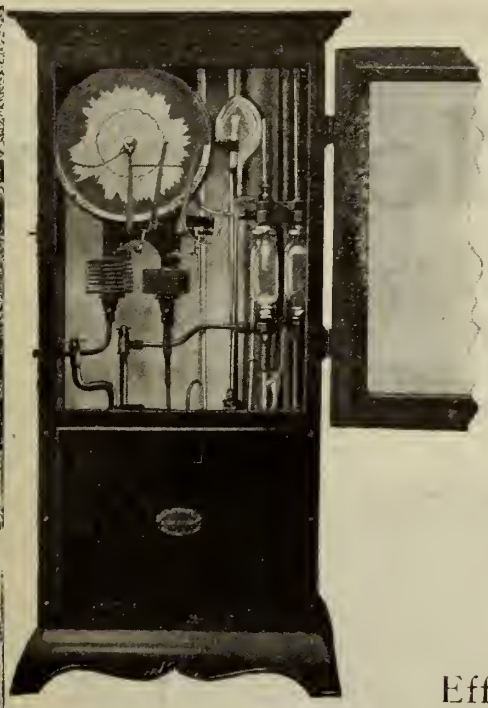

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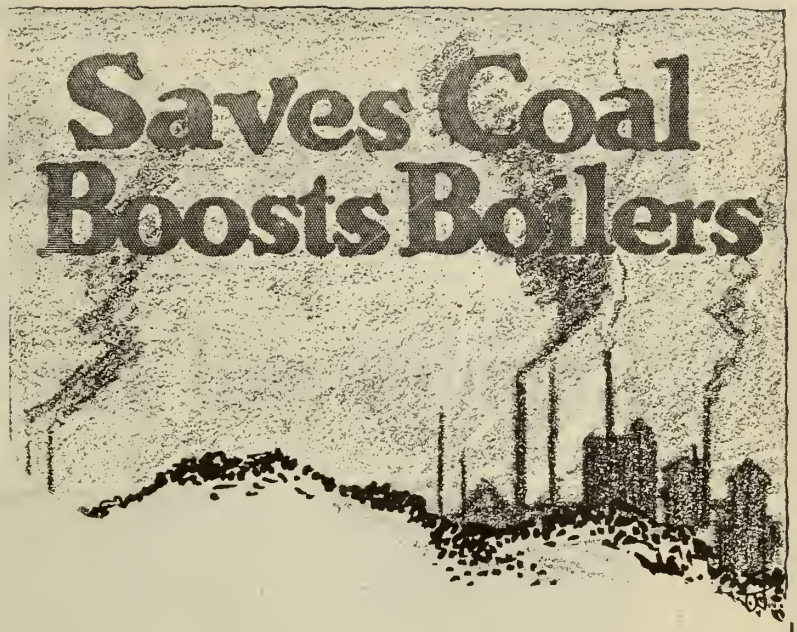

Efficient Combustion under your boilers will save tons of coal each day. Much of the loss in fuel is due to the ignorance of the importance of air or draft. To maintain efficient combustion in your boiler-room it is necessary that your firemen have accurate information regarding the fires.

The Hays Automatic CO_2 & Draft Recorder will show your firemen when the boilers are wasting coal so that they can check the loss instantly. Hays Recorders guide the firemen in the right way by timely information about the fires, thus enabling them to regulate the draft and thickness of fuel bed so that the highest percentage of CO_2 may be maintained.

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sooner or later you will become interested in a Lincoln Welder.

You will want to know all about it—what it will accomplish and what it will save. You will want a Lincoln engineer to conduct an investigation in your establishment. You will permit him to make experimental welds.

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The Lincoln Electric Co. of Canada
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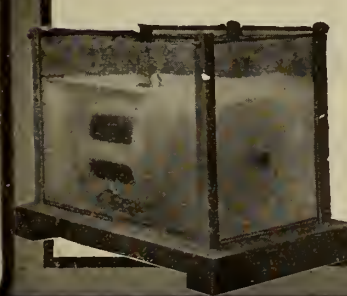

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You can again obtain Genuine "Resisto" Gauge Glasses with the Red Line—

You'll be glad to know this. No more dangerous experimenting with inferior glasses. You can depend upon the "Resisto"---its reputation is your assurance of perfect service.

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Note below the result of a very severe test in which the "Resisto" was tested with several well-known brands of glasses.

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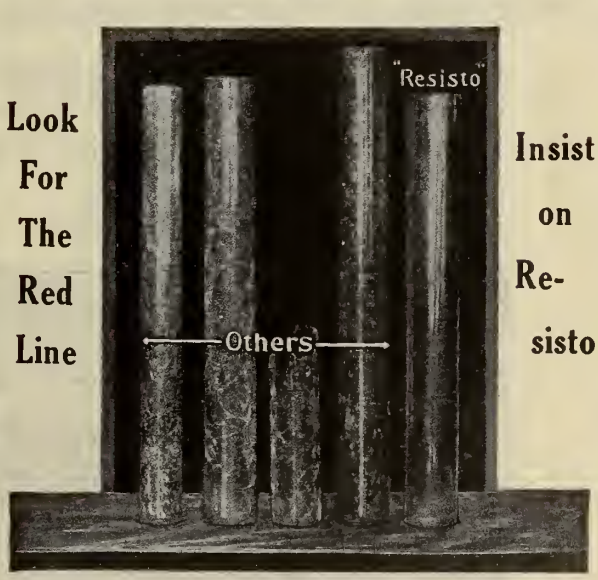

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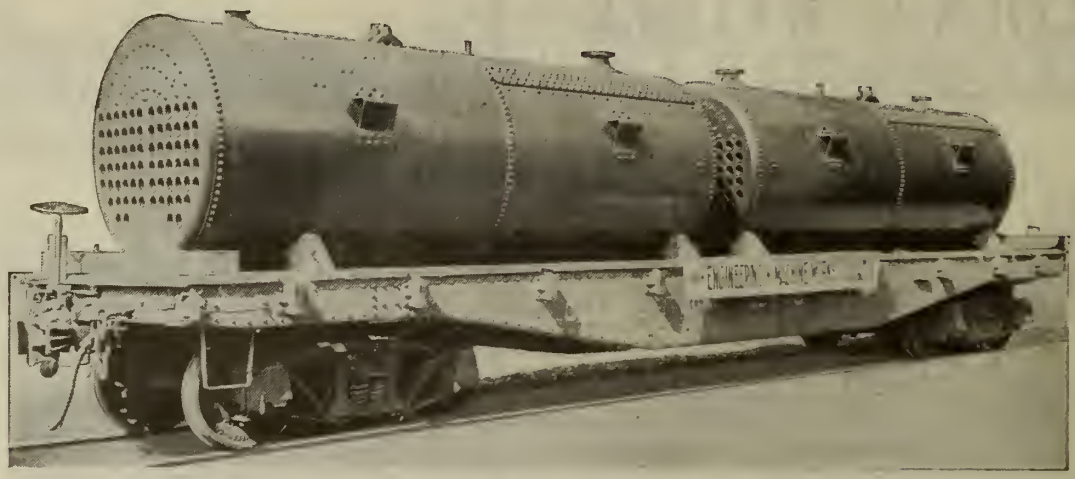


NO SENSIBLE MAN

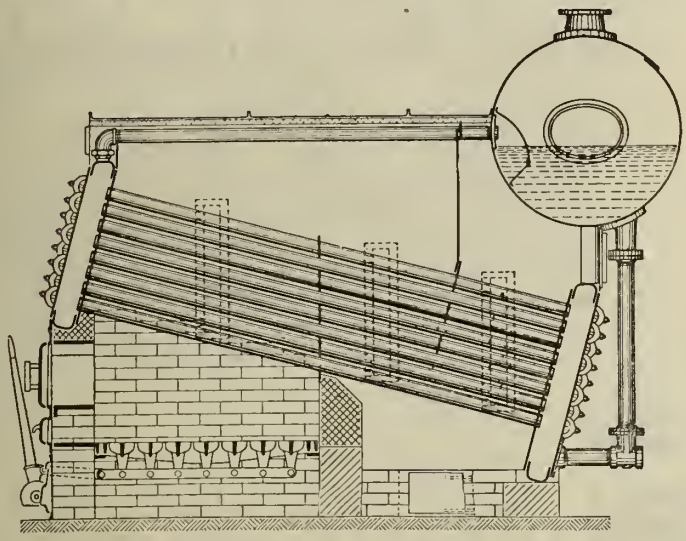
expects the present so-called business depression to continue indefinitely. Canada's position in all fundamentals is too strong to allow anything but a very temporary slowing up in our strides towards national greatness. The wise manufacturer will take this opportunity to set his house in order. We are particularly interested in your steam plant. We say in all seriousness—now is the time to order new boiler equipment. We are in splendid shape to serve you.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

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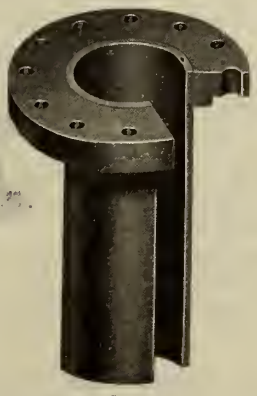

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P H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

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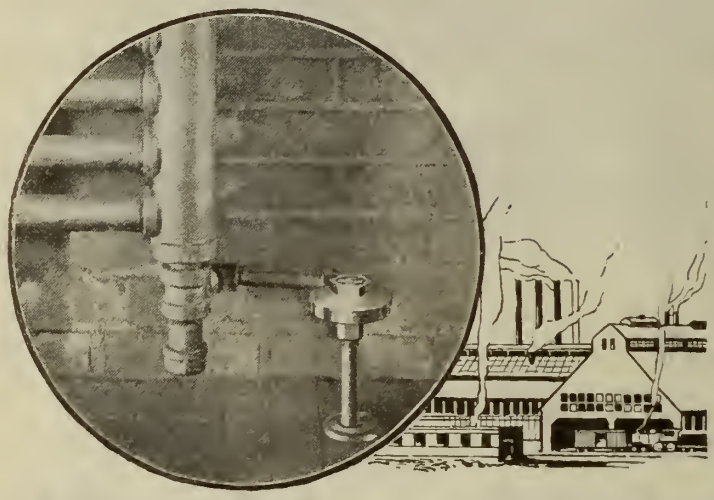
The *Smallest Part* of a Steam Heating System is the Most Important



The Dunham Radiator Tap

IT'S the smallest part of your steam system—the Radiator Trap—that sometimes proves the most expensive. If your trap is inefficient, steam is leaking back into the system. This means wasted fuel and money. Dunham Radiator Traps cannot leak and therefore conserve steam and fuel. Besides saving fuel they put pep into lazy radiators by keeping them hot **all over.**

For proof, ask for our new Bulletin 110, "The Dunham Vacuum Heating System." Send us the boss's name. He will find it interesting, too.

The DUNHAM HEATING SERVICE

C. A. DUNHAM CO., LTD.
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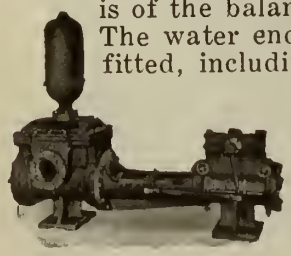
AMERICAN-MARSH PUMPS

SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—
Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN

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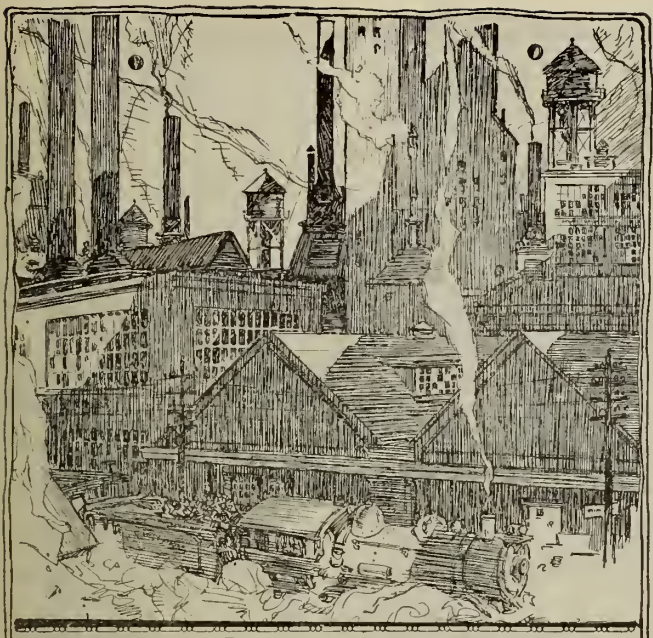


ECONOMY *renewable* FUSES

Knife-blade type Economy Fuse

Industries persisting in the use of "one-time" fuses pay more for electrical protection than those equipped with Economy Fuses.

The famous Economy "Drop Out" Renewal Link makes possible an annual saving of 80% in fuse maintenance costs.

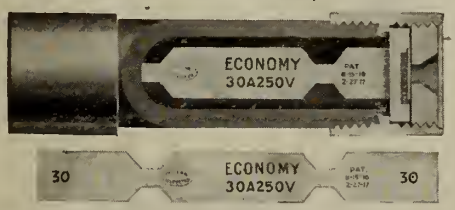
Nothing is destroyed when an Economy Fuse blows but the inexpensive strip of fusible metal.

This is quickly and easily replaced with a new "Drop Out" Renewal Link without delay to men or machinery. The heavy cartridge, end caps and the winged washers which lock the fuse are virtually indestructible and are used again and again.

Check up fuse costs in your plant. And remember that Economy Fuses give maximum protection at minimum cost.

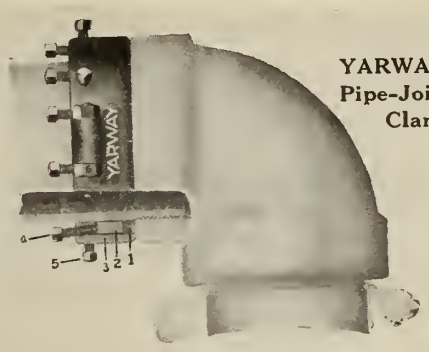
For sale by all leading electrical jobbers and dealers.

Economy Fuse & Mfg. Co. of Canada, Ltd.
UNITY BLDG., MONTREAL, CANADA



Ferrule type Fuses with Economy "Drop Out" Renewal Link

Economy Fuses were the first line using inexpensive bare links for restoring blown fuses to their original efficiency to be APPROVED IN ALL CAPACITIES by the Underwriter's Laboratories.



YARWAY Pipe-Joint Clamp

Description—1. Square packing ring, forced against leaky joint. 2. Inside ring, forced against packing 1 by screws 4. 3. Outside ring, bolted around pipe by bolts 6, secured by set screws 5, prevents slipping when adjusting screws 4.

The Best Insurance Against Leak Losses

With a Yarway Pipe Clamp, one workman can stop most any steam-line leak, large or small—stop it permanently and in less than ten minutes.

Any leak in your steam lines, whatever its size, is a serious matter with coal at its present prices. Yet the cost of a shut-down to replace the damaged section of pipe is even more serious.

Perhaps, in order not to interfere with production, you are overlooking the leaks—and paying the increased coal bills. But if you could have these leaks completely and permanently repaired in a few minutes, with no interference to work, wouldn't you rather save your coal?

YARWAY

Pipe Clamps

The Yarway Pipe-Joint Clamp stops leaky joints. The Yarway Holtite Pipe Clamp stops holes and splits in straight pipe. Both are stocked in all the usual sizes for immediate shipment.

A supply of Yarway Pipe Clamps on hand is the best possible insurance against leak losses. We'll be glad to send you one to test, without obligation. Write for Bulletin No. C-805, and see what users say about them.

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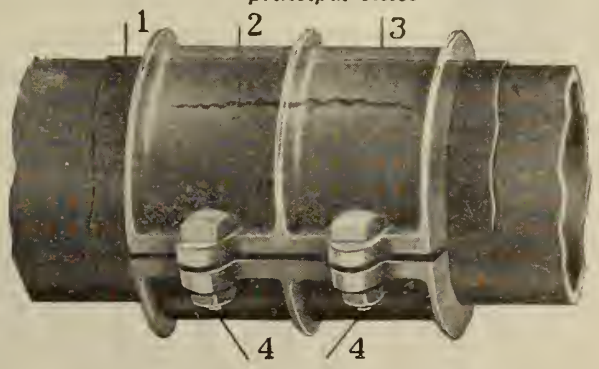
7604-20 Queen St.
Chestnut Hill Philadelphia

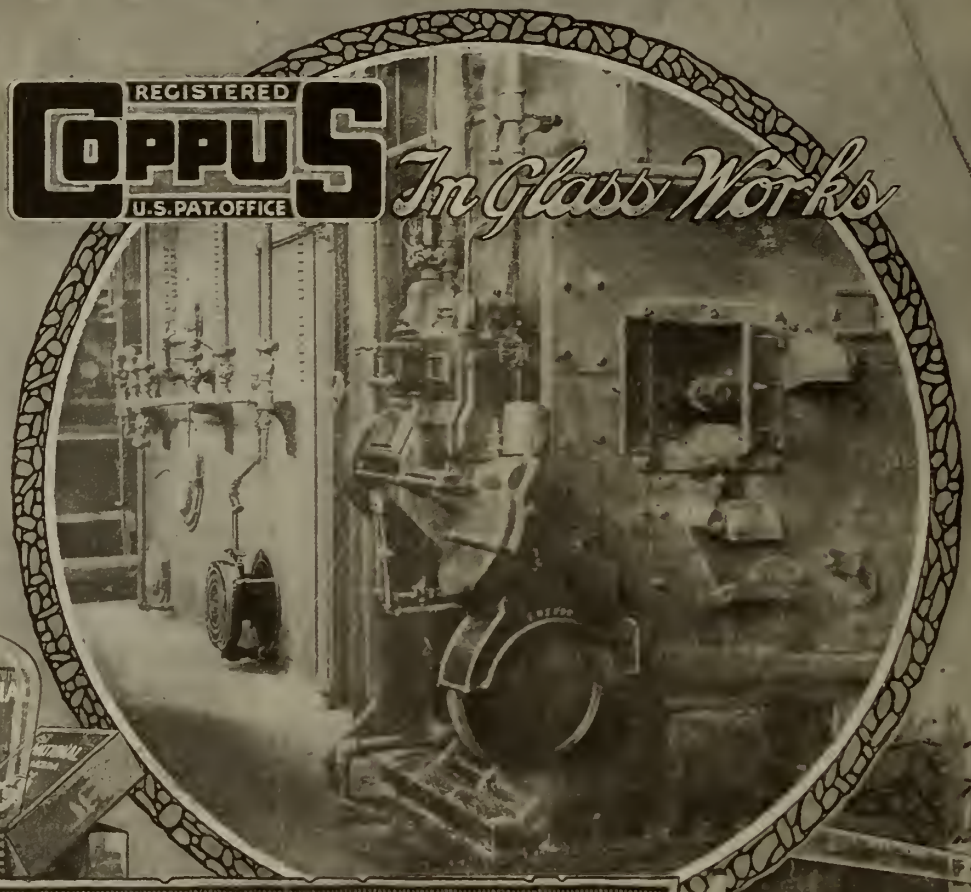
Carried in stock by dealers in thirty principal cities



Yarway Holtite Pipe Clamp

Packing (1) is placed over hole or split (2) in pipe; metal clamp (3) is then placed over packing and around pipe; bolts (4) tighten clamp and hold it in place.

REGISTERED
COPPUS
U.S.PAT.OFFICE
In Glass Works



In the Glass Division Power Plant of the National Lamp Works out in Cleveland, Ohio, they burn gas coal screenings and producer tar difficult fuel to burn economically. Yet with the 4-18" COPPUS Turbo Blowers which they operate, full steam pressure is maintained in their 4-250 H.P. Stirling Boilers and cheap fuel is efficiently burned. Without these Blowers, one of which is shown above, additional boilers would have been necessary last fall. With their aid, however, the heavy plant load is easily handled.

Before the National Lamp Works installed COPPUS Blowers a careful investigation satisfied them that for efficient operation, low steam consumption, and sturdy dependability, COPPUS Blowers stand in a class by themselves. And after practical proof that COPPUS Blowers are all that is claimed for them. Mr. Bretz, Plant Superintendent, expresses himself as "highly pleased with them." In the National Lamp Works, as in thousands of plants in every industry, COPPUS Blowers have proved profitable investments.

Why not find out exactly how and why "COPPUS EQUIPMENT CAN SAVE YOU MONEY?" Write us and our engineers will help you solve your combustion problems. If you haven't a copy of Blower Catalog write for one to-day.

"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

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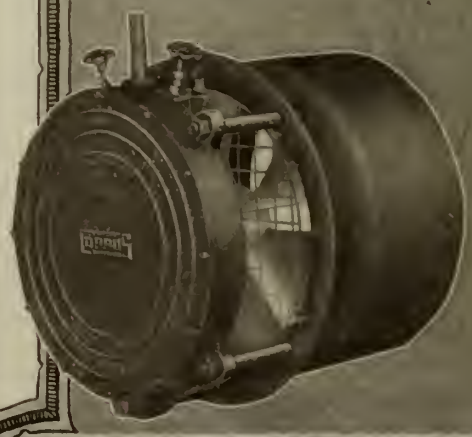

COPPUS TURBO BLOWER

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D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

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Mueller Mfg. Co., Ltd., The.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Can. Link-Belt Co., Toronto, Ont.

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Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Holden Co., Ltd., The, Montreal.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
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CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
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Jas. Morrison Brass Mfg. Co., Toronto.
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Can. Fairbanks-Morse Co., Ltd., Montreal.
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Can. Link-Belt Co., Toronto, Ont.

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Morse Chain Co., Ithica, N.Y.

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Taylor Instrument Co., Rochester, N.Y.

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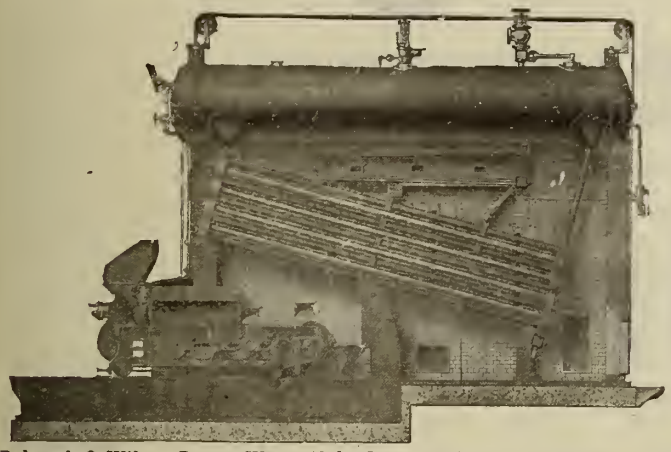

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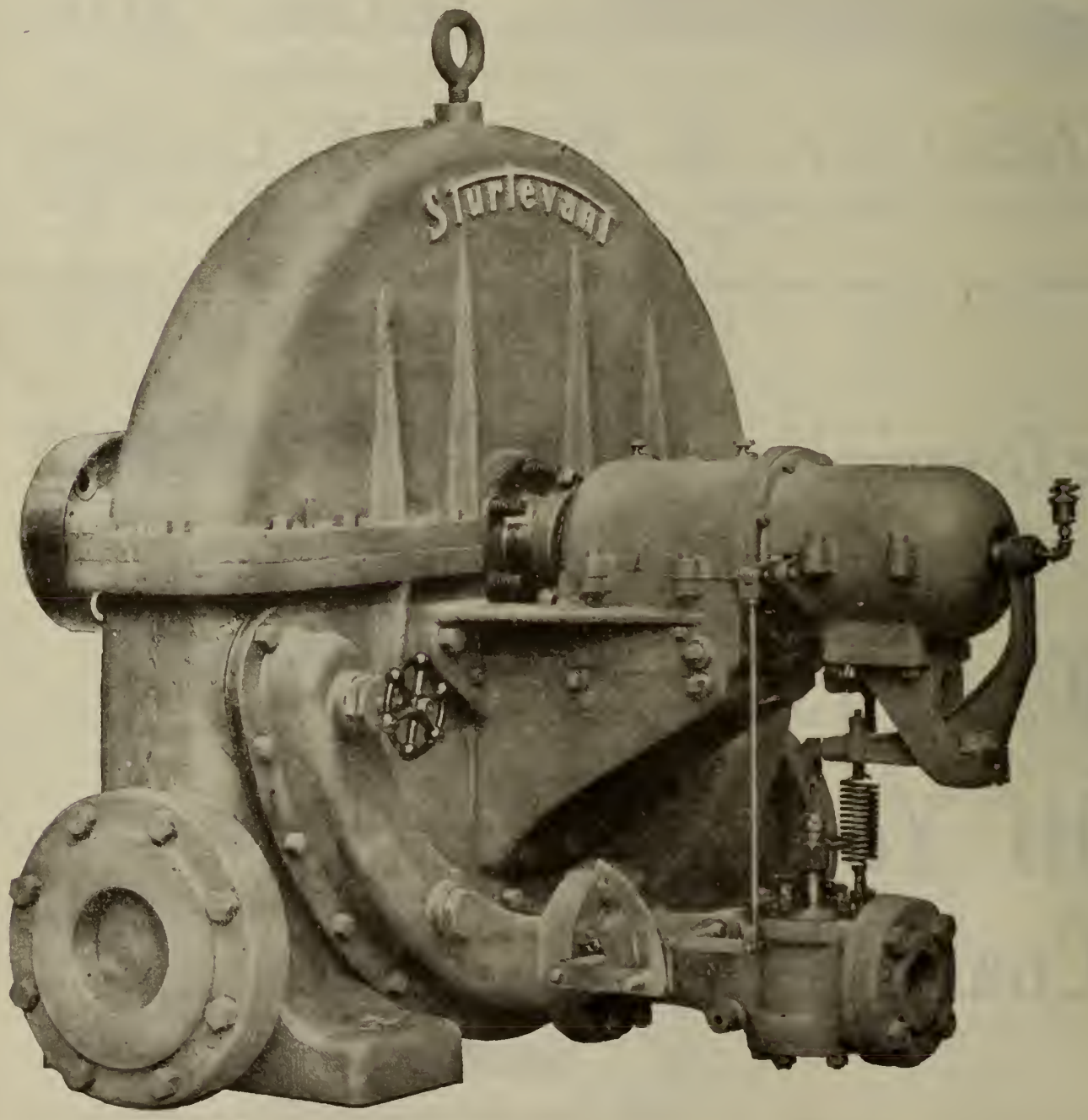

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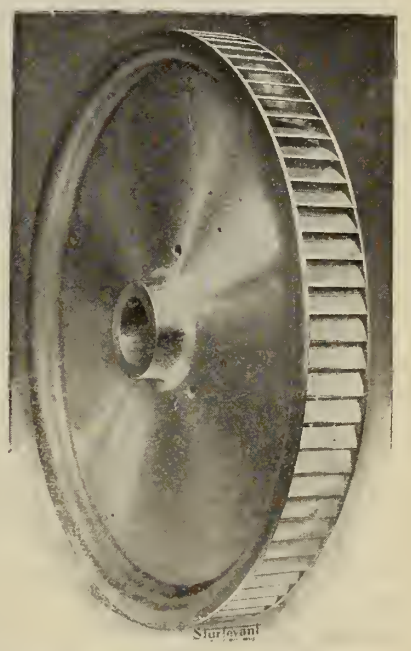

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Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
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Jas. Morrison Brass Mfg. Co., Toronto.
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Valve Engineering Company.

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MacGovern & Co., New York.
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Smart-Turner Machine Co., Hamilton.
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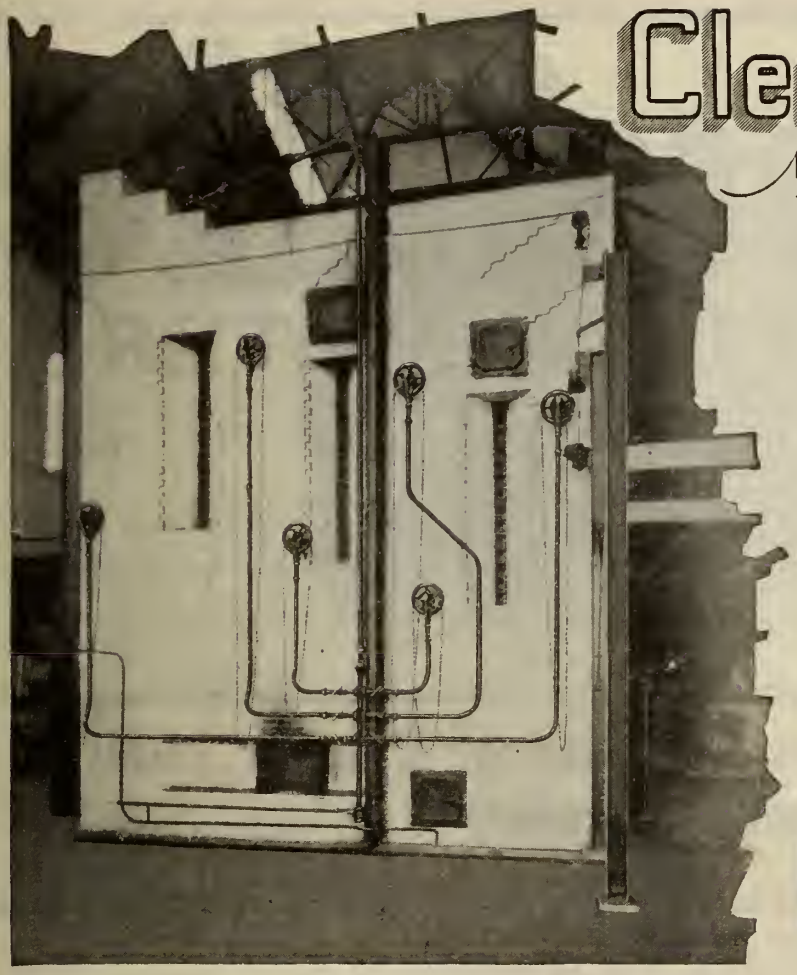

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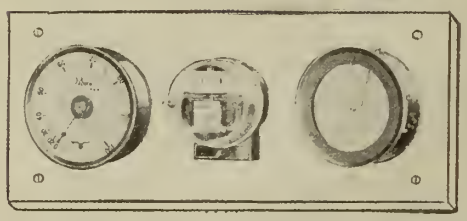

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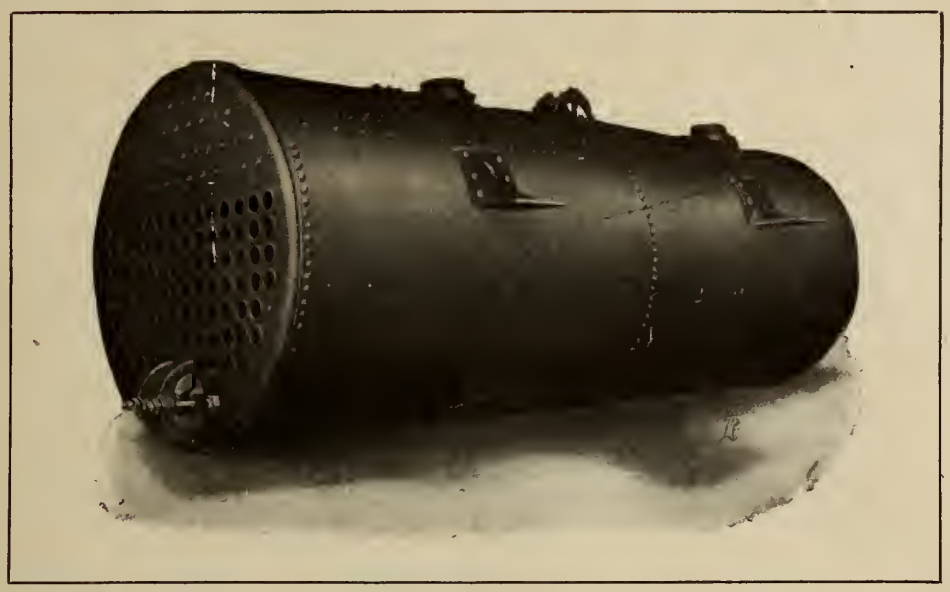

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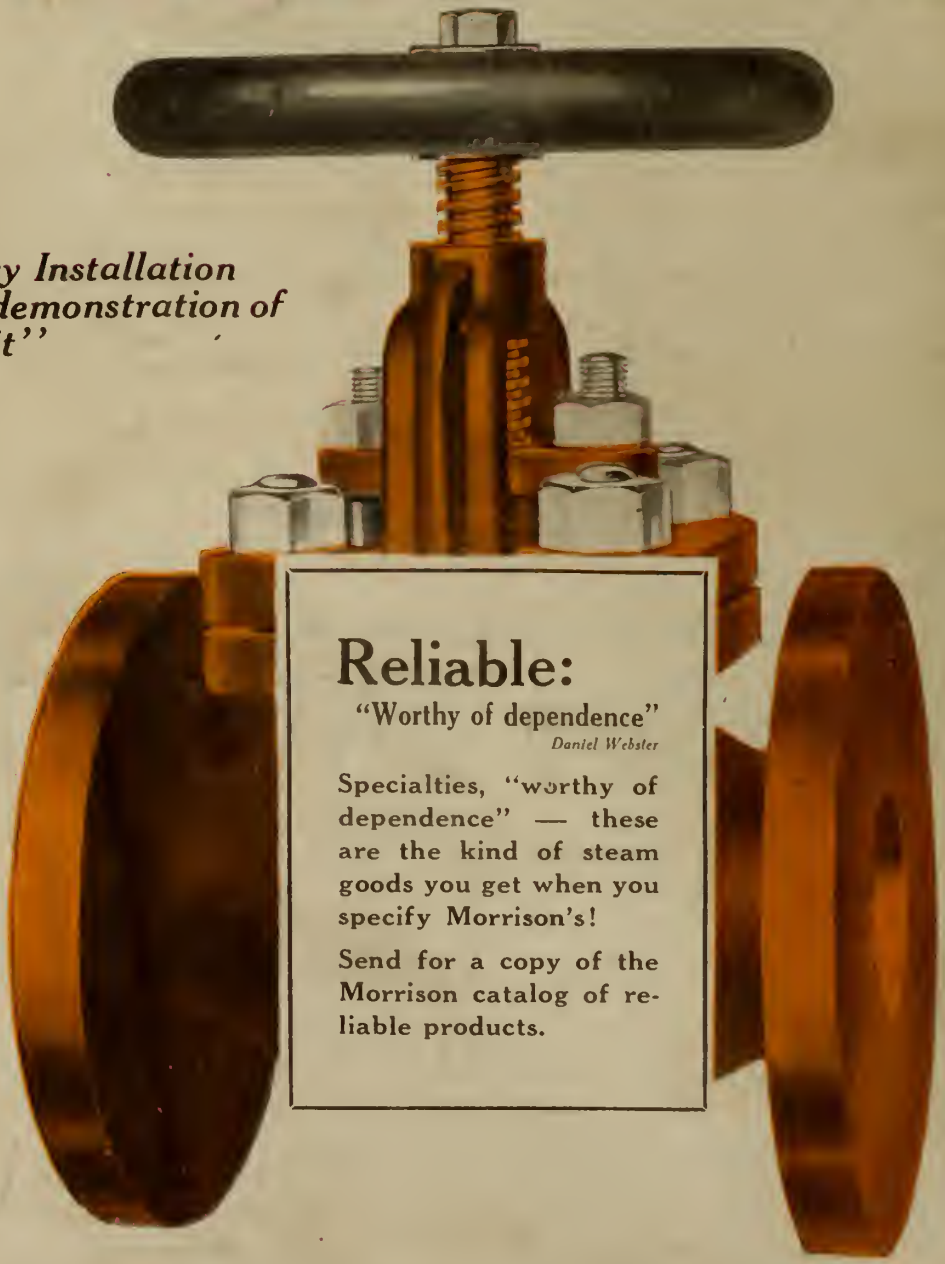

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6. Added profits will result.

By substituting grab hooks for the conveying bucket, the same system can be adapted to handle timbers, steel, baled materials and innumerable other commodities.

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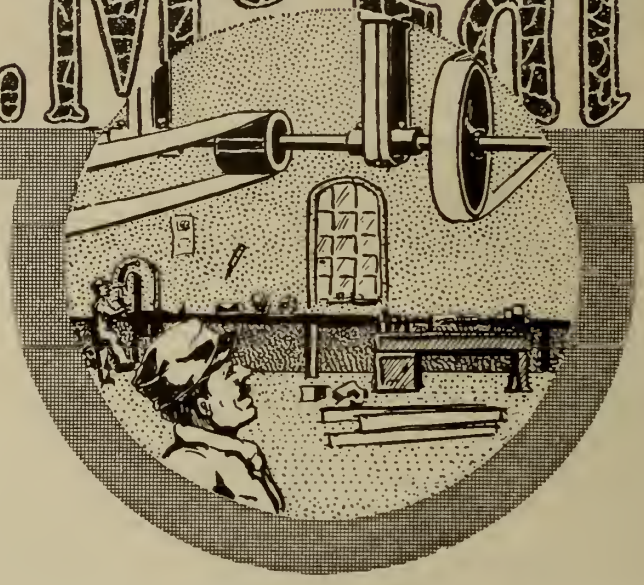
127-147 THIRTEENTH STREET, ELKHART, IND., U.S.A.

Originators, Patentees and Manufacturers of Conveyors, operating Gravity-Filled Bottom Dump Bucket over Monorail.

Sold in Canada by M. A. KENNEDY, LIMITED, 106-110 Richmond St. West, Toronto, Canada. Phone Adelaide 7511

D. K. McLaren's



GENUINE OAK

GENUINE OAK

What of the Belting You Depend Upon?

Is the service which it gives all you wish for? A belt may transmit power at a loss of 10, 20 or even 30 per cent. and be considered a fairly good belt. But—why lose 20 or 30 per cent. of your power when D. K. McLaren's Genuine British Oak Tanned Leather Belting would hold your loss to less than 3 per cent.?

Minimum stretch, minimum slippage and fewer breaks are the results you can expect—and get—from D. K. McLaren's Belting.

D. K. McLaren's Leather Belting is made exclusively from close-trimmed butts of the finest selected hides, tanned by the Genuine British Oak Method until extremely tough and pliant.

D. K. McLaren's Leather Belting is as nearly stretchless as a belting should be.

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IMMENSE shop facilities, standardized manufacturing plus over 81 years of designing, improving and manufacturing pumps and pumping machinery have resulted in apparatus of suitable design for every power plant pumping duty.

This broad range and varied choice of apparatus together with over 200,000,000 boiler horse power successfully satisfied since 1840 justifies specifying Worthington for power plant apparatus. The Worthington engineering corps always stand ready to co-operate in order to obtain greatest possible results from apparatus selected.

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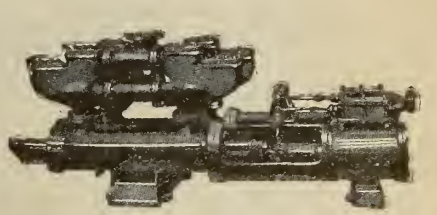
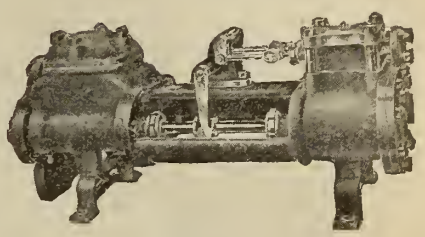
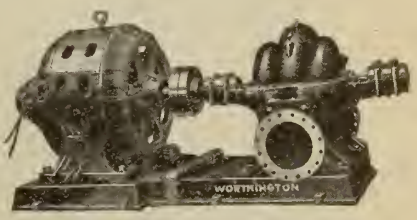


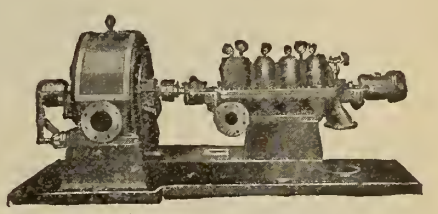
Pot Valve Boiler Feed Pump



Duplex Packed Piston Pump



Split Casing Double Suction Volute Pump



Double Suction Turbine Pump, Boiler Feed Pattern

Because of hot water pumping, centrifugal pumps become steam bound. Worthington double suction centrifugal boiler feeder is equipped with a floating sealing ring device which prevents seizing at close clearance points between rotor and casing.

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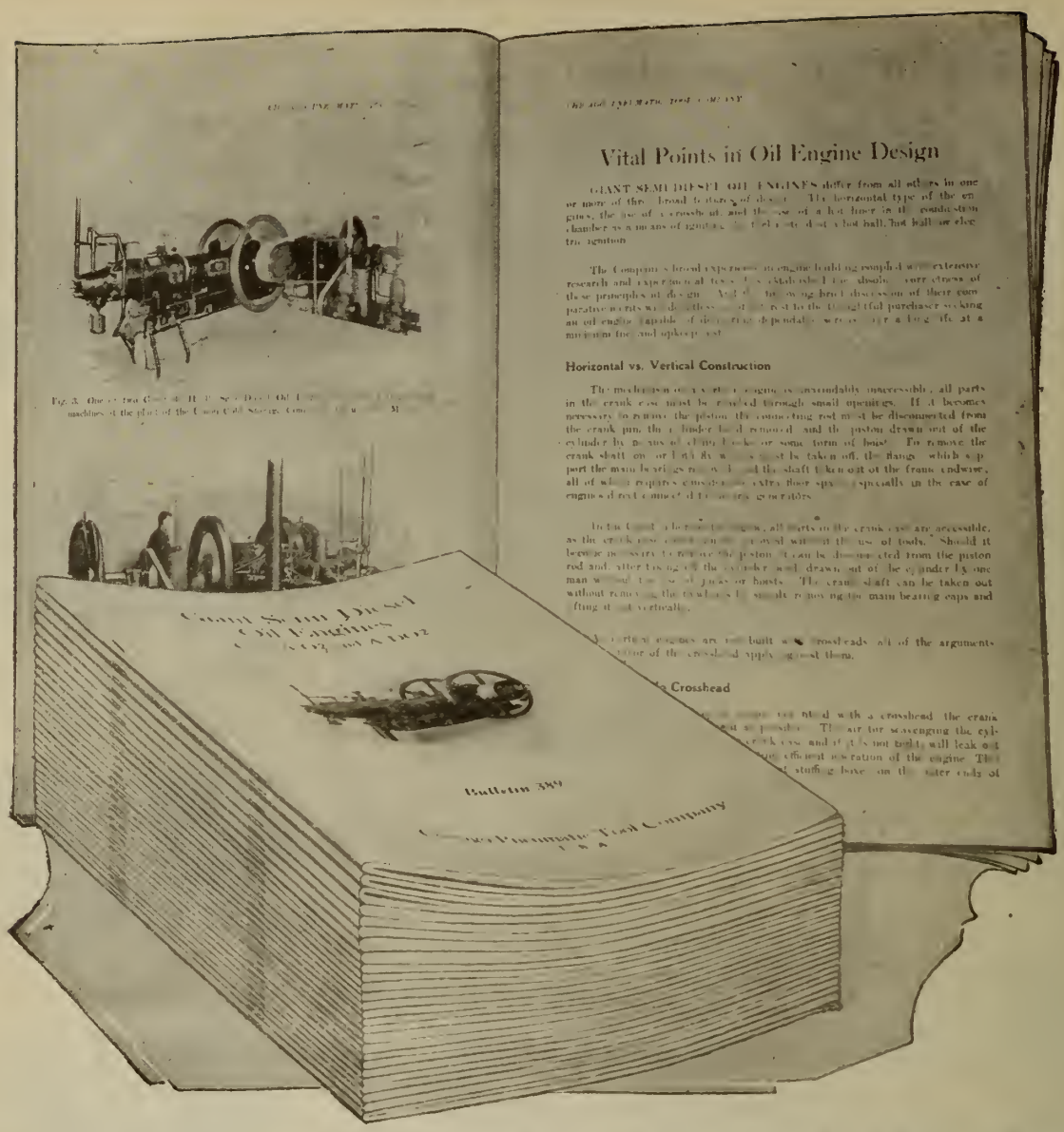
Epping-Carpenter, *Pittsburgh, Pa.*

POWER HOUSE, January 20, 1921. Vol. XIV. No. 2. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



Every power user should read this book

The low cost of fuel oil for power, coupled with the time-proven dependability of the Giant Oil Engine is enabling power users everywhere to adopt oil as their standard fuel, and Giant Oil Engines their standard prime movers for operation on it. The book, "Giant Semi-Diesel Oil Engines" is an instructive publication from which every power user can glean many facts about oil engine design, construction and operation—facts that point the way to better, more economical power. Request your copy through the Company Branch nearest you.

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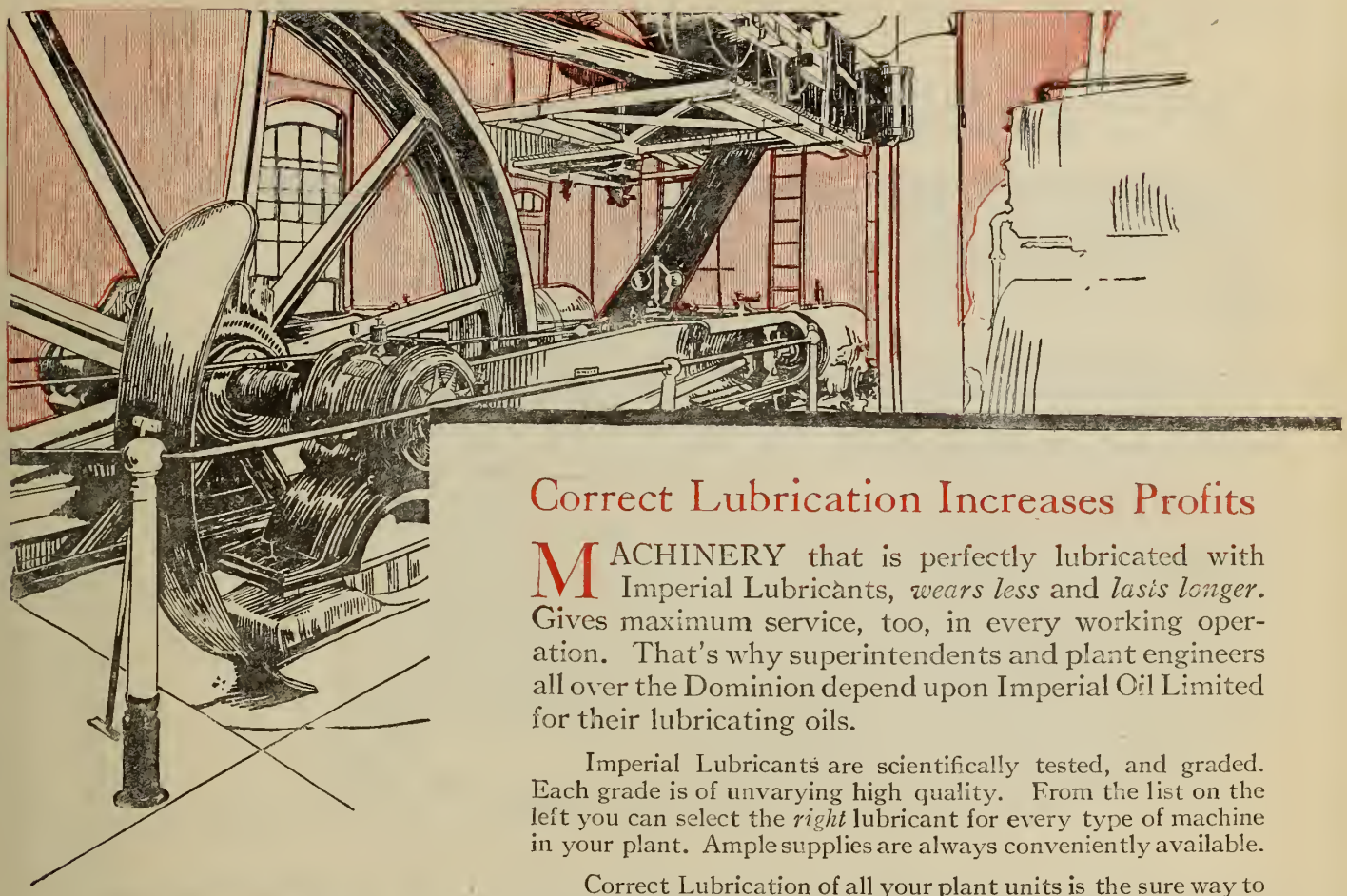

Correct Lubrication Increases Profits

MACHINERY that is perfectly lubricated with Imperial Lubricants, *wears less* and *lasts longer*. Gives maximum service, too, in every working operation. That's why superintendents and plant engineers all over the Dominion depend upon Imperial Oil Limited for their lubricating oils.

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The regular use of Imperial Lubricants guarantees power-saving economy, increased efficiency and more profitable plant operation.

If in doubt about your present lubricating practice, Imperial Lubrication Engineers will be glad to advise you. Write to 56 Church St., Toronto.

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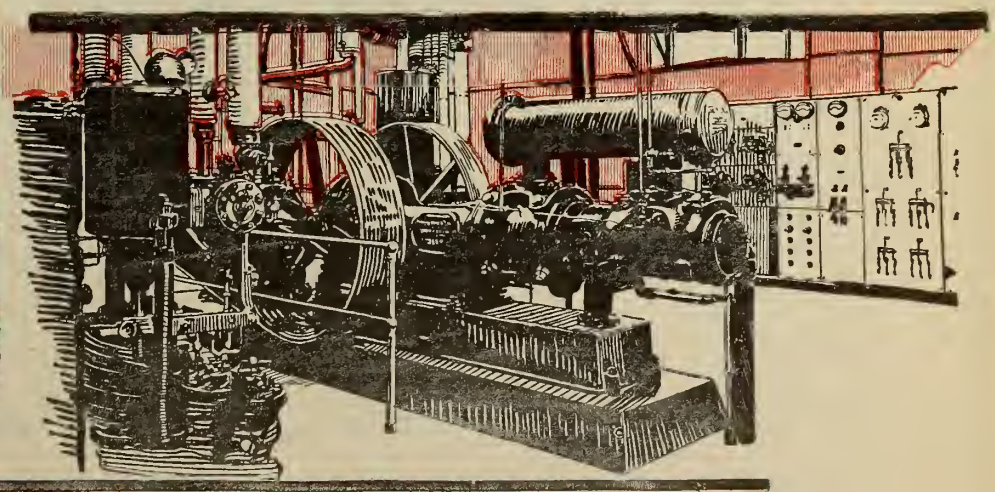

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Power-Heat-Light-Lubrication

Five Canadian Refineries Branches In All Cities

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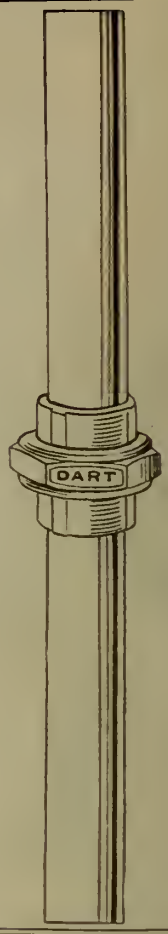
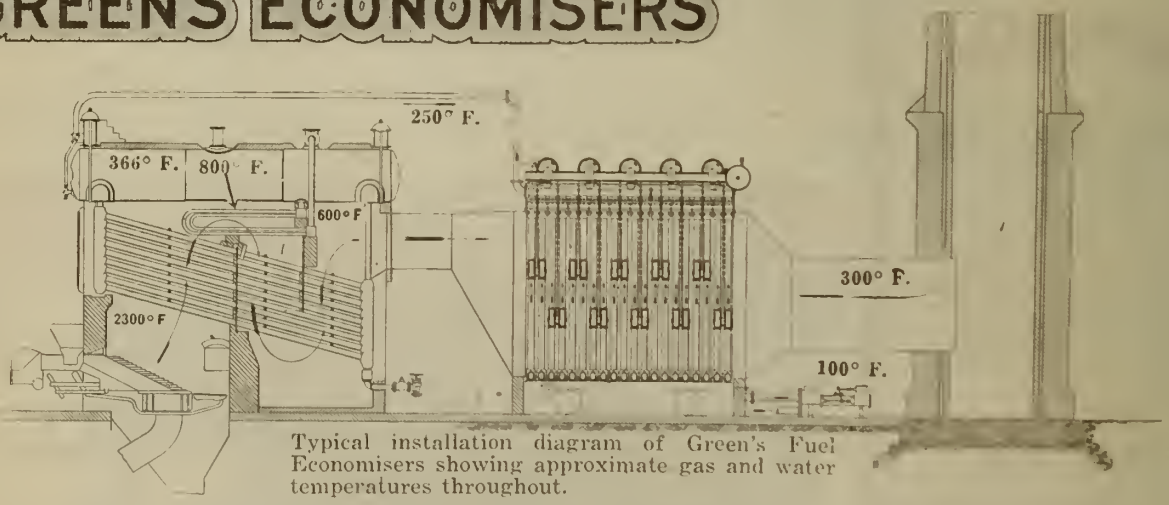
PIPE COUPLINGS



Manufactured by Dart Union Co., Limited, Toronto, Ontario

GREEN'S ECONOMISERS



Typical installation diagram of Green's Fuel Economisers showing approximate gas and water temperatures throughout.

At the recent Chemical Exposition in New York, during the fuel economy conference, one of the speakers, a noted engineer, stated that by far the greatest heat loss in the boiler room was in the sensible heat of the exit gases.

The use of extra boiler surface to cool gases below 500° F. does not pay because below 500° F. the heat absorbed per square foot of heating surface does not equal the cost of maintenance. The use of **Green's Economiser** is the **most economical method** for recovering this loss it will reduce the gas temperature to a low figure at minimum cost by transferring the heat of the gases to the feed water, under boiler pressure, thus allowing the boiler to be supplied with water at a temperature slightly lower than the steam itself

Write for our bulletin No. 151, or call for one of our engineers to inspect and make recommendations for your conditions.

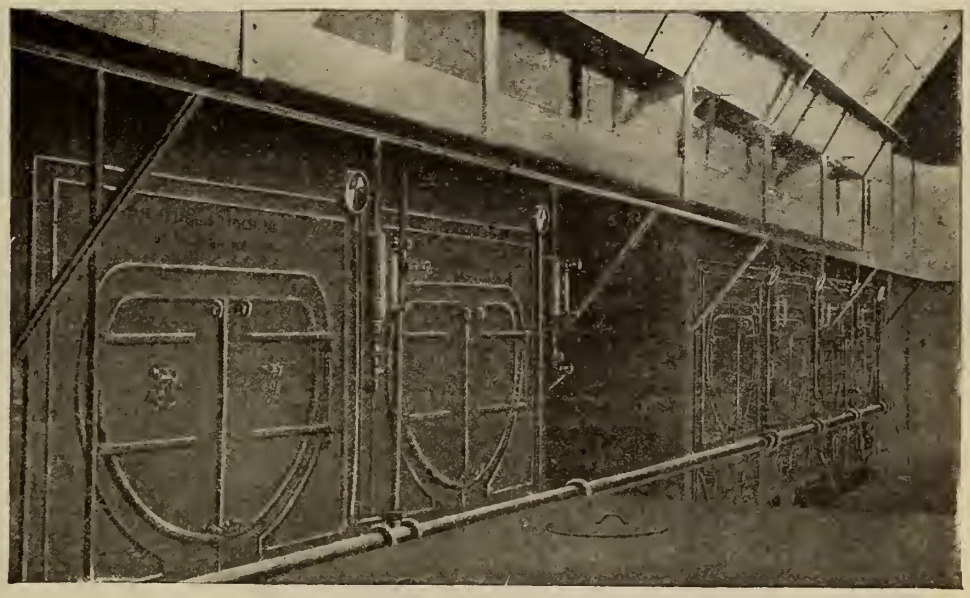
GREEN'S ECONOMISER, LIMITED.
TORONTO

For Some Boiler Sizes—

We have the materials here, ready, now—

If your steam plant needs additions or renewals now is the time to talk business.

Let's all join in keeping the wheels turning. We're doing it—you too.



Engineering and Machine Works of Canada, Limited

St. Catharines, Ont.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal

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STRENGTH—GOODNESS—QUALITY

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Every Glass

TESTS OF HIGH PRESSURE GAUGE GLASS

Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

Tensile Strength—Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.

Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK

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DURABLA

This is the Vulcan method of cleaning boilers of the Stirling Steep Tube Type—BETWEEN THE TUBES.

Why CLEAN Boilers Burn Less Fuel

All boiler manufacturers agree on and emphasize the fact that their boilers burn fuel most efficiently and economically when the furnace fire and water in the tubes are permitted to come into contact with each other with a minimum of interference. Thus, boilers whose tubes are kept free from soot, ash and scale accumulations consume less fuel in order to maintain a given steam pressure than boilers which are regularly neglected, or only partially cleaned.

Vulcan Soot Cleaners assure thorough cleanliness so far as the soot and ash are concerned. They are responsible, in most plants where used, for saving between 4 per cent. and 8 per cent. of the fuel consumption, or for reducing the preventable losses 20 per cent. to as high as 40 per cent.

While you're thinking of it, write and ask for the interesting folder, "SPENDING $796 TO SAVE $1,017.40!"

Vulcan Soot Cleaners are manufactured for all types of water tube and return tubular boilers, superheaters and economizers. For quotations, write to either Canadian office, giving type of boiler, number of tubes wide and high, and steam pressure.

This is the famous Vulcan diagonal method of blowing as used in boilers of the staggered tube type—B&W, Goldie & McCulloch, etc.

The Vulcan Soot Cleaner Company

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The Safe and Certain Boiler Cleanser

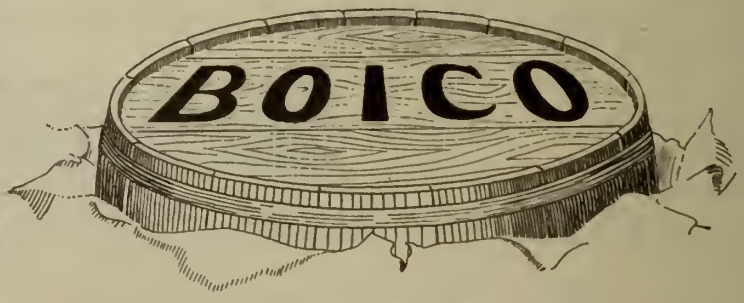
PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

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With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

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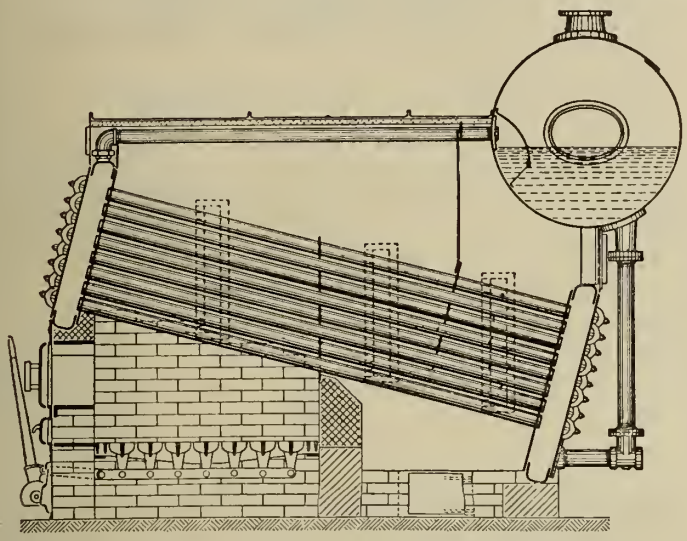
Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec. Adam Davis, Cobalt, Ont.

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

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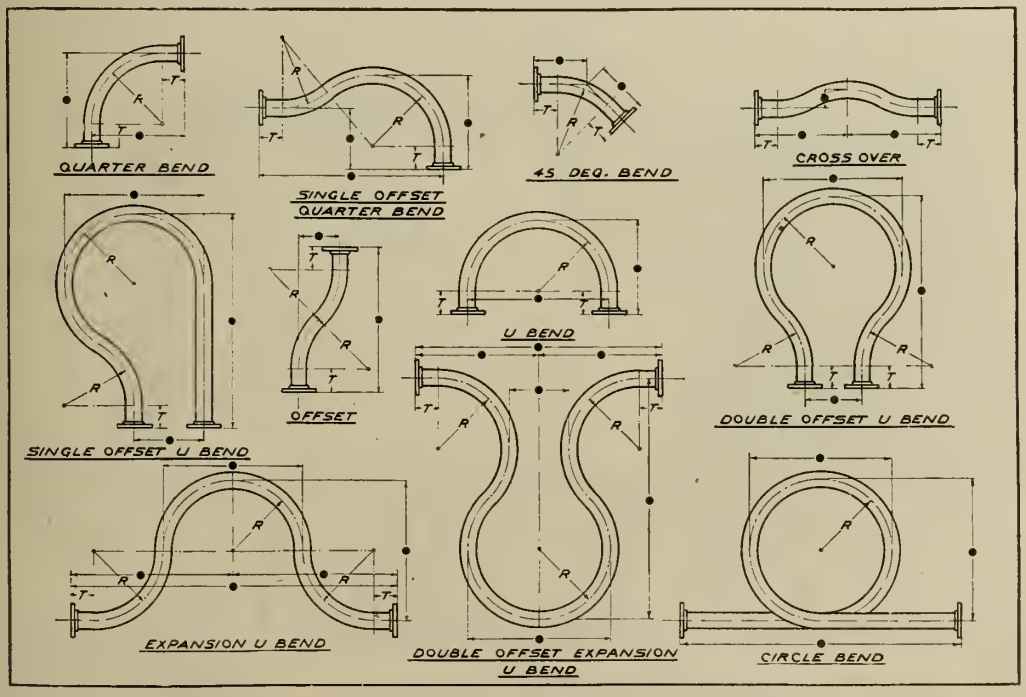
P⊗H WROUGHT PIPE BENDS



ALL KINDS AND SIZES UP TO 10" DIAMETER

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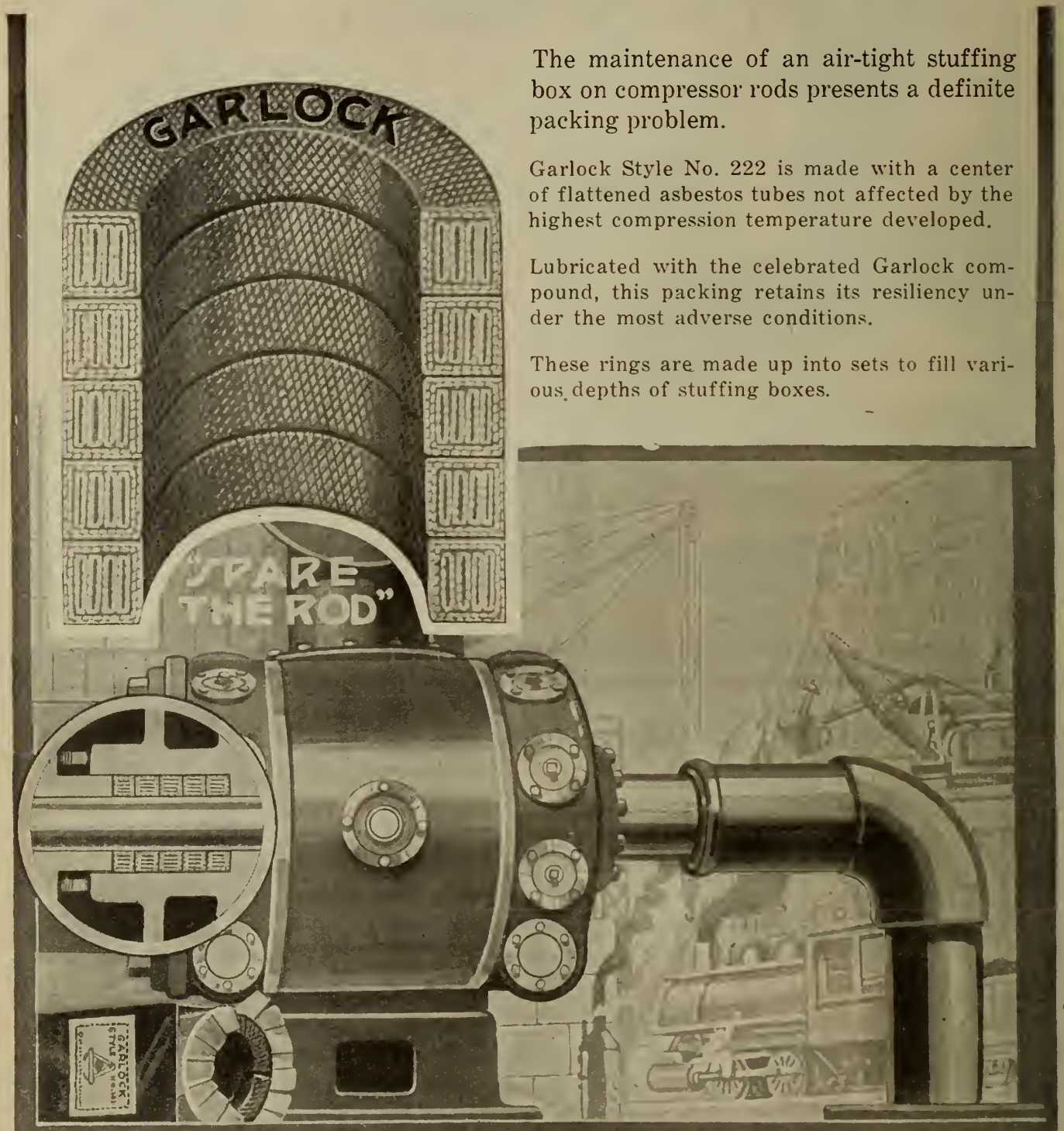
AIR COMPRESSOR PACKING



The maintenance of an air-tight stuffing box on compressor rods presents a definite packing problem.

Garlock Style No. 222 is made with a center of flattened asbestos tubes not affected by the highest compression temperature developed.

Lubricated with the celebrated Garlock compound, this packing retains its resiliency under the most adverse conditions.

These rings are made up into sets to fill various depths of stuffing boxes.

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Hamilton, Ontario

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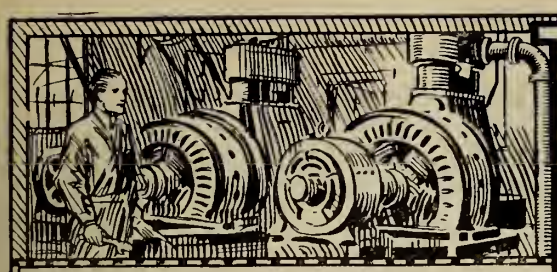

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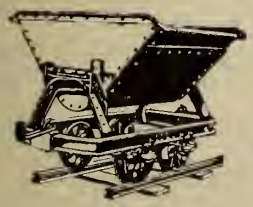

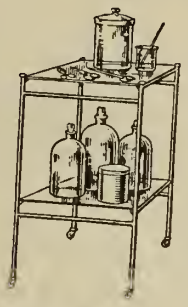

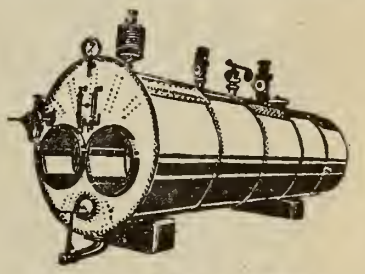

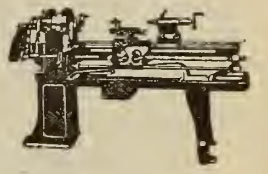

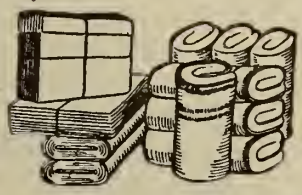

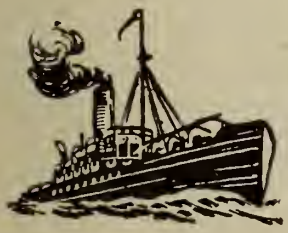

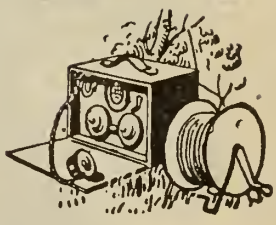

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No Weakness At Any Point

Fig. 402

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TYPE "K" GATE VALVE
FLANGED
IRON BODY—BRONZE MOUNTED

Our thorough knowledge of Valves and Valve requirements has taught us the value of correct proportion and proper distribution of metal.

Such knowledge, acquired through some 56 years of practical manufacturing experience, means just this to the purchaser of valves—that every valve bearing our Trade Mark (the name "Jenkins" within a Diamond, cast on the body) is **designed and proportioned for the maximum service,** that it is safe and dependable under all conditions, and that there is no weakness at any point.

And the line is complete — a Valve for Every Service — Every one tested before leaving the factory.

Supply houses everywhere carry the complete Jenkins line. When buying or specifying valves insist upon the **genuine** Jenkins — known by the Diamond Trade Mark.

Write for Catalog No. 8.

TRADE JENKINS MARK
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TRADE JENKINS MARK Jenkins Bros

"MEAD-MORRISON"

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Single Roll

COAL CRUSHER

Made in Canada

Capacity Single Roll Crusher, 50 to 70 tons an hour.

Capacity Double Roll Crusher, 100 to 150 tons an hour.

McCASLIN CONVEYORS
GRAB BUCKETS
SKIP HOISTS
COAL HANDLING MACHINERY

Dependable Service

AGENTS:
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CANADIAN MEAD-MORRISON CO
LIMITED
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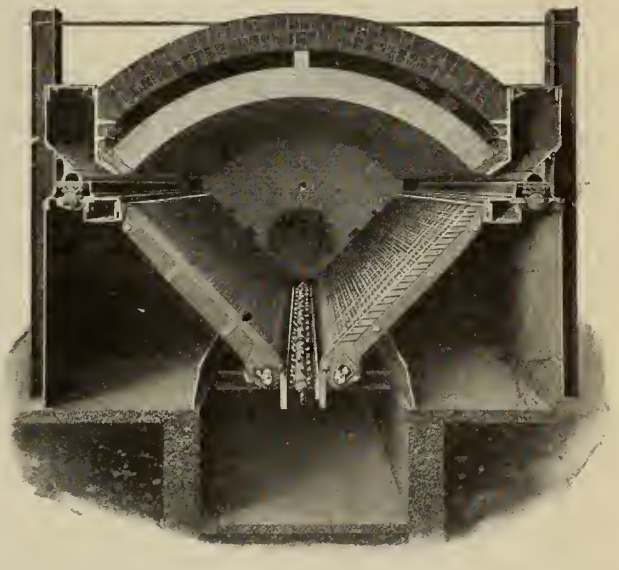
MURPHY AUTOMATIC FURNACES



For Any Boiler
50 h.p. and Up

Any boiler from 50 h.p. and up can be equipped with the MURPHY FURNACE. The *smaller plant* can, therefore, enjoy all the economical advantages of fuel and labor savings *without resorting* to forced draft.

To-day over 6,000 *boilers* are fired by MURPHY FURNACES. You will find them used in nearly every branch of the industry—from hospital to industrial and central station service.

MURPHY FURNACES "burn any fuel that has heat in it." They double the output of the plant "without one penny for draft."

Our Catalogue "HM-1" shows how MURPHY FURNACES can be installed under any type of boiler—50 h.p. and up.

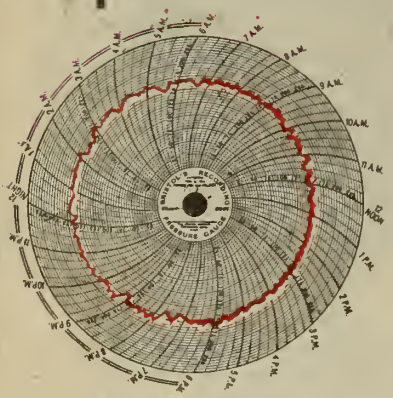
For information on RILEY UNDERFEED STOKERS for large boilers, see last month's advertisement or send for RILEY STOKER Catalogue "HR-1."

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

THE MASON TRADE-MARK

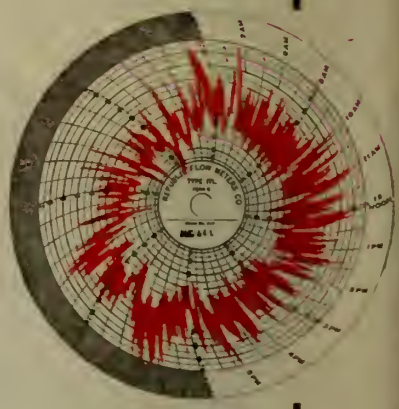
"SERVICE"

The charts on this page are from the plant of one of the largest Rubber Factories in Canada. In one of their departments it is absolutely necessary that steam be delivered at an even pressure, regardless of boiler pressure and the amount of steam used. The Mason Reducing Valve has been chosen to do this important service, as absolute reliability is essential—any variation of pressure, and therefore of temperature, meaning serious loss.



FIRST—THE BOILER PRESSURE

Fluctuating between
140 lbs. and 170 lbs.



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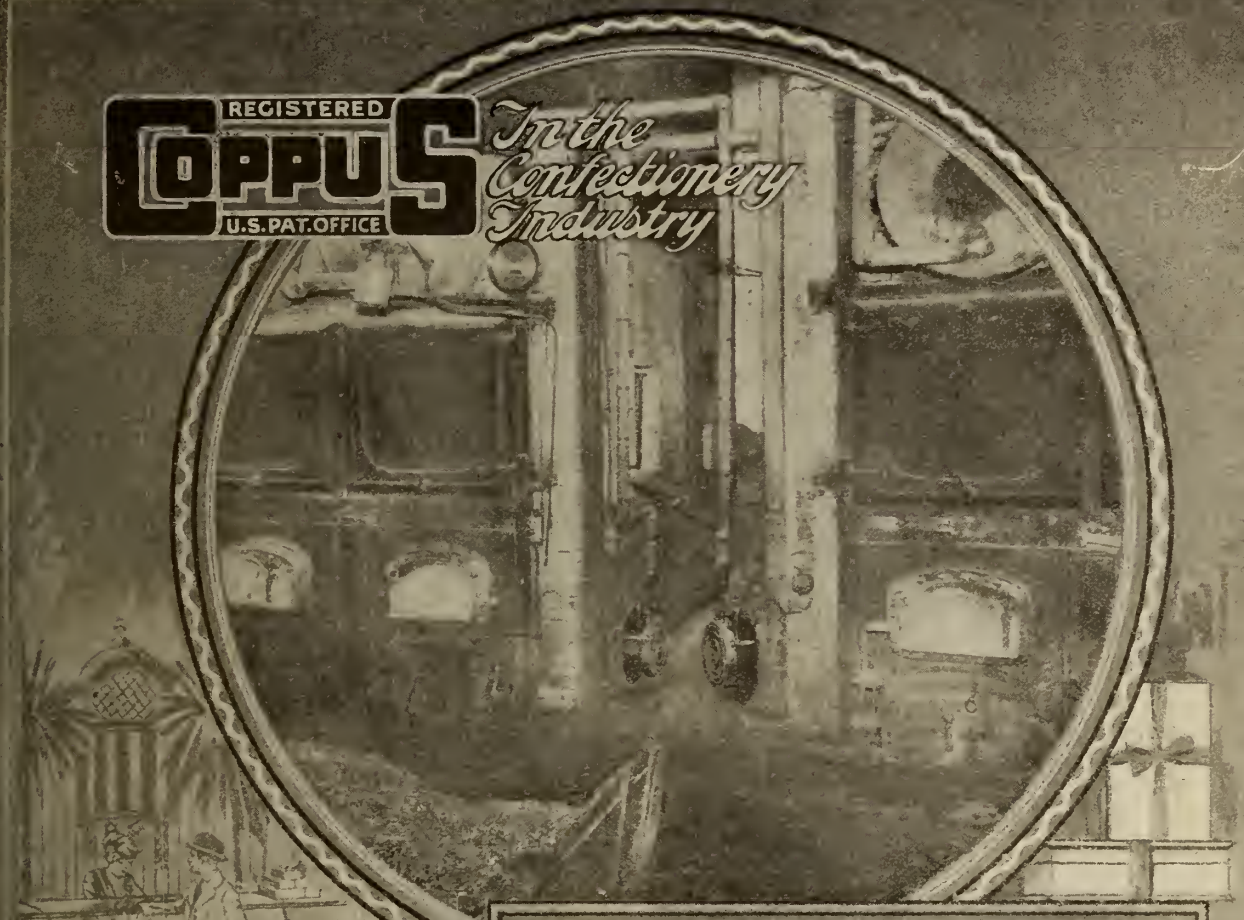

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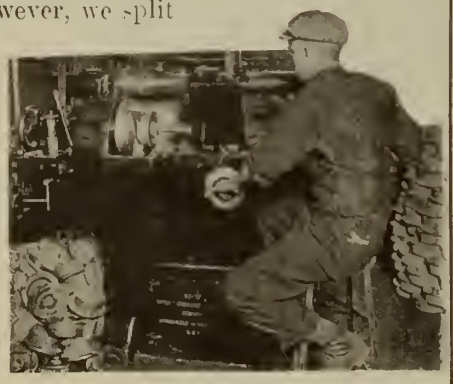

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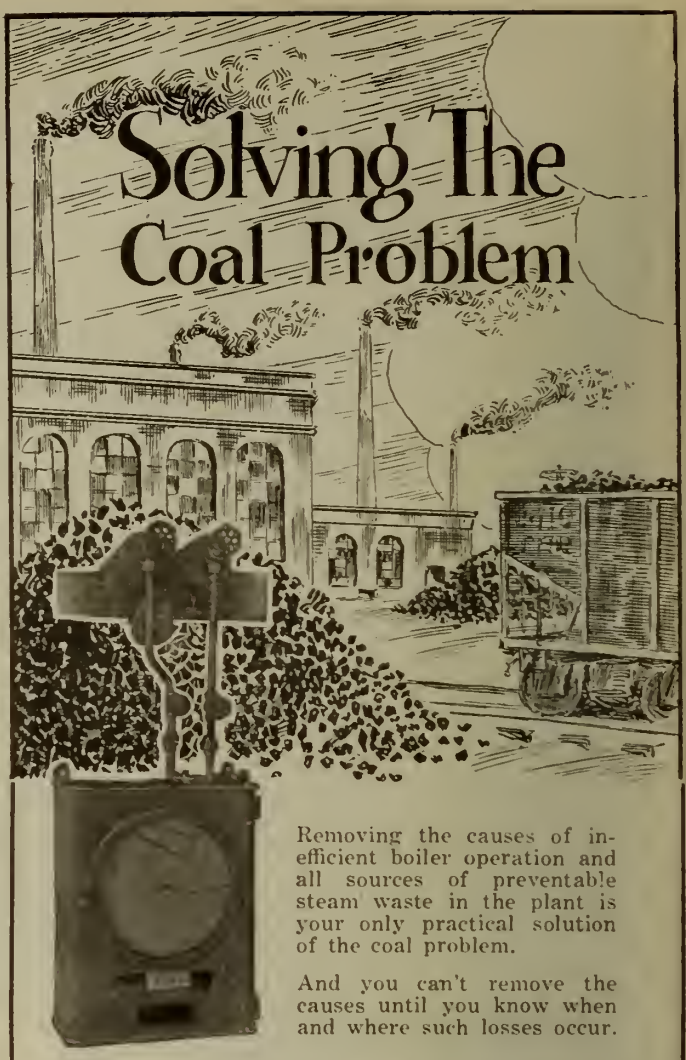

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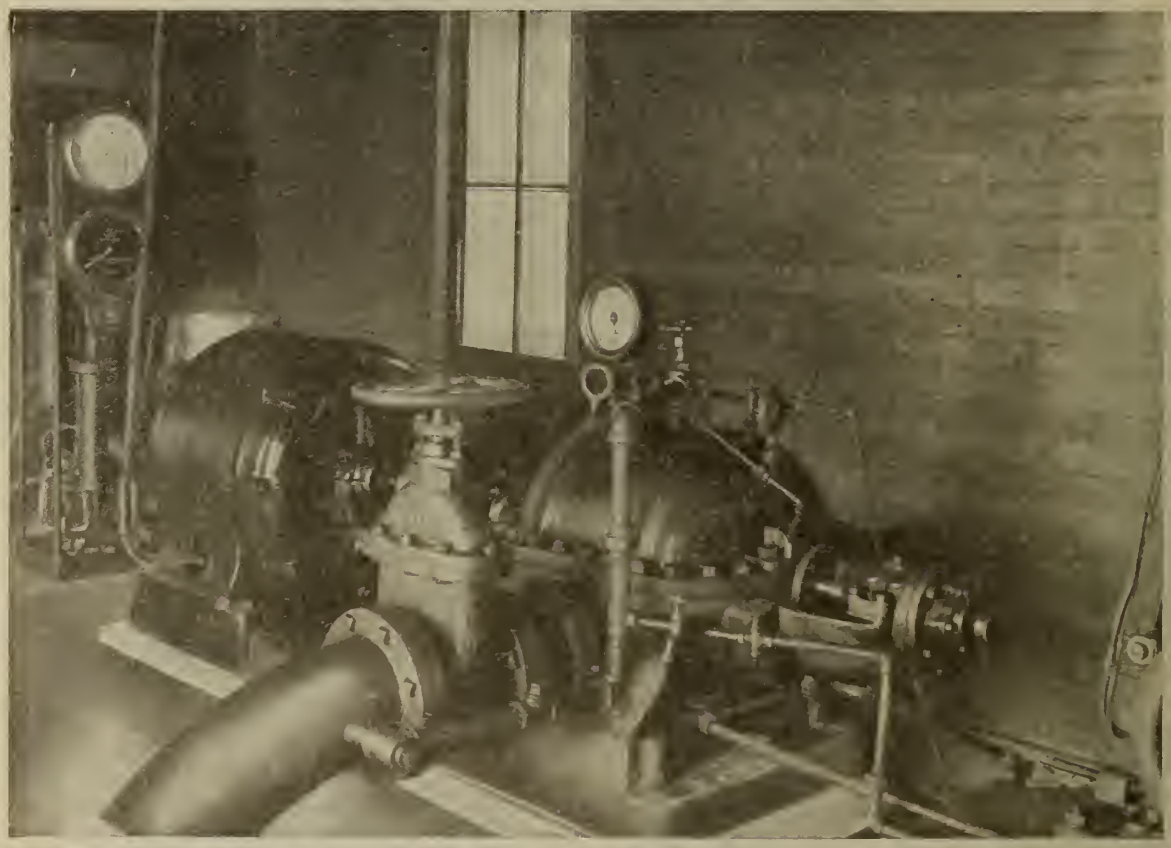

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Emissivity of Heat From Various Surfaces

An Account of a Number of Tests Carried Out at the Engineering Experiment Station of the University of Illinois Leading to Some Interesting Results.*

By V. S. DAY

I. Introduction

IN May, 1919, it was observed in these tests that greater temperature reduction occurred in air passing through bright tin pipes covered with asbestos paper, such as are commonly used in furnace heating, than occurred in air passing through the same bright tin pipes uncovered, all other conditions in the comparative tests being the same. It was therefore evident that the actual heat loss was greater through the asbestos paper-covered pipes than through the same pipes uncovered.

This fact was reported at the annual spring meeting of the National Warm-Air Heating and Ventilating Association, Columbus, Ohio, June 11, 1919, as follows: " . . We found that we lost about 35 per cent. more heat through the pipe covered with asbestos paper than through the same tin pipe not covered. . . . This great loss amounts to approximately 5 per cent. of the coal consumed. . . . Furthermore, it costs from ten to fifteen dollars to cover the heat pipes of the average house installation with asbestos paper."*

Because of the inefficacy of many of the present warm-air furnace heat insulating methods, it is evident that a complete study of various insulating materials, coverings, and surfaces would be justified.

3. Acknowledgments.—Credit is due Professor A. C. Willard for the original idea of the scheme for testing the samples, and for the keen support which, as the active supervisor of the investigation, he gave this work.

Professor A. P. Kratz gave valuable advice and assistance in the use of the thermocouples.

4. Significant Conclusions.—The results of the tests have been given some publicity heretofore, but not in the complete form presented in this bulletin. The following significant results as applied to warm-air furnace heating are deserving of special emphasis.

(1) The use of thin sheets of asbestos paper on bright tin heat pipes results in a waste of heat. The use should be abandoned.

(2) Uncovered bright tin pipes are more efficient carriers of heated air than asbestos paper-covered bright tin pipes. See item (4).

(3) This fact is true regardless of the degree of brightness of the tin surface.

(4) No small number of applications of asbestos paper will suffice as an insulator. Several thicknesses are necessary to make a covering equal in this respect to the bare tin.

(5) The accumulation of dust and dirt on the pipes does not greatly alter the amount of the loss.

(6) The heat loss from warm-air furnace pipes covered with one layer of asbestos paper is a serious item in the cost of heating, amounting to more than 5 per cent. of the coal consumption, depending upon the number and size of the pipes used.

(7) The fact that pipes are partly protected from convection currents of air by joists and studding does not greatly affect the loss.

(8) Unless the insulation excels the uncovered bright tin in heat insulation properties it should not be used.

(9) Such materials are available and the tests have shown their merits.

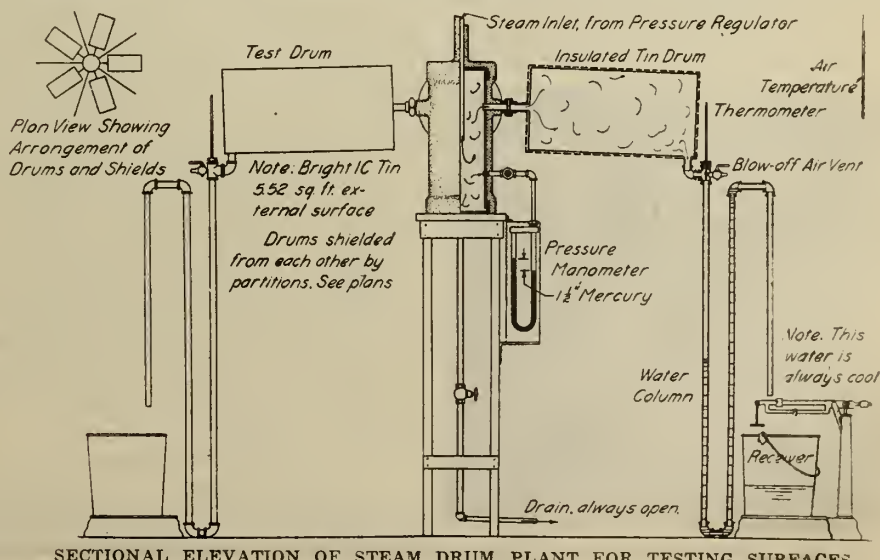
II. The Testing Equipment

The report, which was made at Columbus, Ohio, gave the results of tests on the Auxiliary Testing Plant (see Fig. 6).* It was difficult to obtain entirely satisfactory data on this plant because of the variation in the velocity of the air flowing up the leader and the difficulty of correctly measuring the temperature of the air, as described later in this bulletin. It was therefore decided that a special apparatus should be devised which would eliminate possible errors in temperature measurements.

*Bulletin No. 117 University of Illinois.

*Proceedings of the National Warm-Air Heating and Ventilating Association, p. 70, June 11, 1919.

*University of Illinois Engineering Experiment Station, Bulletin No. 112, "A Report of Progress in Warm-Air Furnace Research." by Prof. A. C. Willard, pp. 45-49.

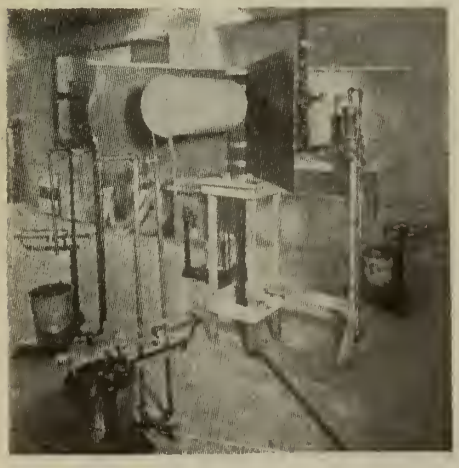

Steam Inlet, from Pressure Regulator
Test Drum
Insulated Tin Drum
Air Temperature Thermometer
Plan View Showing Arrangement of Drums and Shields
Note. Bright IC Tin 5.52 sq. ft. external surface
Blow-off Air Vent
Drums shielded from each other by partitions. See plans
Pressure Manometer 1½" Mercury
Note. This water is always cool
Water Column
Receiver
Drain, always open

SECTIONAL ELEVATION OF STEAM DRUM PLANT FOR TESTING SURFACES FOR HEAT EMISSIVITY.

5. Description.—The apparatus here described (Figs. 1 and 2), was the one used in the tests reported in this bulletin. It consisted of low pressure steam heated drums, five in number, surrounding a central steam header from which the drums drew their supply of steam. The drums were accurately uniform in size, ten inches in diameter by twenty inches in length and were made of sheet metal of the kind to be tested. Steam was condensed in the drums by the cooling action of the air surrounding them and was discharged through water seals connected to each drum. These seals were U-tubes made of pipe, and were long enough to contain a water head of four feet. As the steam condensed the seals became filled with water; the condensate then dripped over into receivers as fast as it accumulated. The water in the seals cooled to room temperature before it dripped into the receivers so that evaporation was not influenced by the heat of the water in the receivers. Each receiver was mounted on a small weighing scales accurate to one one-hundredth pound.

A mercury manometer was used to obtain the pressure of the steam in the central header, and since the temperature of the steam for any known pressure may be taken directly from steam tables, it was possible to determine the temperature of the medium within the drum with great accuracy. A pressure regulator in the steam supply line held the pressure constant within a small fraction of a pound, about 0.2 pound being the variation during a test; as the temperature change for the pressure variation was negligible, the temperatures were uniform and accurate within one degree.

No thermometers were required for determining the steam temperature, but one was used in each drum at the point of outlet of the condensate to detect the presence of air in the drums. The readings of these thermometers decreased upon the formation of air pockets in the lower part of the drums or in the connected piping. Air could be blown out of small petcocks located near the thermometers in the piping. No effects on the co-efficients were noticeable when steam was allowed to escape for short periods from these petcocks, which could therefore be opened during a test to discharge any small accumulation of air.



PHOTOGRAPH SHOWING THE PRINCIPAL FEATURES OF THE STEAM DRUM PLANT.

Test N° 9 — WARM AIR FURNACE RESEARCH, ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS — Date 10-30-1919 — Name W. P. Day

Subject: Steam Drum Tests of Heat Insulating Materials
Clockwise Order of Drums is N°s 2, 1, 4, 3

No.	Time	INST. NO.	N°1 IC Tin Scales Reading ; 251-40	N°1 IC Tin Weight Water	N°2 Asbestos P. Scales ; 254-39	N°2 Asbestos P. Weight H_2O	N°3 3 Ply Air-cell Scales ; 231-37	N°3 3 Ply Air-cell Weight H_2O	N°4 Paint Scales ; 251-32	N°4 Paint Weight H_2O	Room T T_1 2T4-15-3	Room T T_2 2T4-17-3	Steam Press In. Hg. Gage.
1	8:45 p.m.		8.88		11.21		4.54		2.11		80.1	80.2	1.70
2													
3	6:45 a.m.		19.78		28.38		10.00		20.24		82.3	82.5	1.70
4													
5	Diff.			10.90		17.17		5.46		18.13			
6	Evap Correct			+0.11		+0.11		+0.11		+0.11			
7	Total 10 Hours			11.01		17.28		5.57		18.24	81.2	81.3	1.70
8				lb.		lb.		lb.		lb.			
9													
10													
11			Air Valve Temperatures										
12			T_1		T_2		T_3		T_4				
13			2T4-18-7		2T4-18-3		2T4-18-16		2T4-18-4				
14	8:35	All valves	blown 5 minutes										
15	8:41			215		212		211		212			
16	6:40 a.m.			215		210		212		213			
17													
18													
19													
20													
21			Calculations										
22													
23			$T_{steam} - T_{air} = 215 - 81 = 134°F$										
24													
25													
26			$K_1 = \frac{971 + 11.01}{10 \times 5.53 \times 134} = 1.44$ Btu/sq ft/Hr/1°F for Drum N°1										
27													
28			Correction for pipe loss of 1.00 Btu										
29			$144 \times 5.53 - 1.00 = 553$ M										
30			$K = 1.26$ Btu/sq ft/Hr/1°F										

A SAMPLE DATA SHEET FOR A TYPICAL TEST.

The drums were shielded from radiation from each other by blackened compo-board partitions. These partitions did not in any way interfere with the flow of natural air currents. The temperature of the air was measured by thermometers suspended at the elevation of the drums at convenient positions nearby. The thermometers were not affected by radiation from the drums.

Thus the actual measurements involved were simple and were not liable to serious error. These measurements consisted of the weighing of the steam condensed, the reading of the pressure of the steam, and the reading of the room air temperature.

III. The Tests

6. Operation.—The tests reported herein, forty in number, with four drums under steam in each test, were carried out at night when the doors and windows of the large laboratory were closed. No air currents were noticeable near the apparatus. A period of ten hours was chosen for the duration of a test as that time was sufficient to permit accumulations of condensate great enough to render negligible the slight error in weighing. These quantities of water varied from 5 to 20 pounds depending upon the surface material of the test drums. The steam pressure was constant on any given test within 0.2 of an inch head of mercury. In all the tests there was only one case in which the thermometers indicated the presence of air in the drums at the end of ten hours operation. The greatest variation of temperature of the surrounding atmosphere during any night was four degrees Fahrenheit. A recording thermometer was used to show the uniformity of the laboratory temperature.

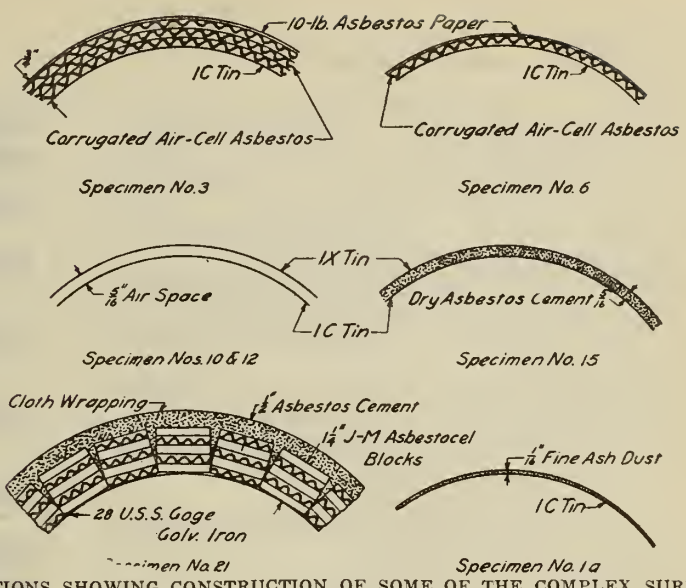
The drums were tested in different positions around the steam header in order to compensate for any irregularity in the flow of steam to the drums or in the currents of air about the drums. As no irregularities were noticeable in the values of the co-efficients of emissivity for the various positions, the practice

was abandoned after the first four drums were tested in the interchanged positions.

One drum, of bright tin not insulated, was in operation in all tests. Its performance served as an indication of any lack of uniformity in the conditions existing throughout the tests.

In order to make correction for the loss of water by evaporation from the receivers, a receiver of water was balanced on a scales and the loss in ten hours actually determined by weighing. After several trials in which the loss ranged from 0.10 to 0.12 pound it was decided to use the value 0.11 pound. This amount was applied as a correction to all the weights of water. Every test was repeated until the results obtained were found to agree within very small limits. In no case are the data reported, the result of less than two tests, and in most cases four were run. Two tests were considered sufficient if the results agreed within one per cent. of their mean value.

7. Specimens Tested.—A complete list of the drums tested is given in Figs. 5 and 5a. In the list will be found a description of the insulation or the surface material, the actual area of the drum exposed to the steam, and an abstract number assigned to the drum (which will be useful in connecting the description with the results reported later in this paper). Fig. 4 shows sections through some of the insulations which were of complex construction.



SECTIONS SHOWING CONSTRUCTION OF SOME OF THE COMPLEX SURFACE COVERINGS.

IV. The Calculations

In calculating the co-efficients of emissivity for the various surfaces it was assumed that heat of the vapor was entirely given up, upon condensation, to the air through the walls of the containers and the connected piping. Tests on the low pressure steam-line supplying the drums show a steam quality of over 99 per cent. The expression for the co-efficient is, therefore, calculated as follows:

$$K_1 = \frac{rW}{A\,(t_s - t_a)} \quad . \quad . \quad . \quad (1)$$

in which, K_1 = B. t. u. per sq. ft. per hr. per 1 degree F.

r = latent heat of one lb. of the steam.

W = weight of condensate per hour.

t_s = temperature of the steam.

t_a = temperature of the surrounding air.

A = area of the drum exposed to the steam.

Correction must be made for the loss of heat through the half-inch pipe of which the water seal was made. This loss is not accounted for in the calculation for K_1 above. Three lineal feet of the half-inch pipe were exposed to the steam. The correction is made by using a co-efficient of emissivity for this pipe of 2.50 B. t. u. per sq. ft. per hr. per 1 degree F. and the exposed area of 0.375 sq. ft., or, 2.50x0.375 = approximately 100 B.t.u. per hour per 1 degree F. to be subtracted from the heat loss, or,

$$AK_1\,(t_s - t_a) - 1.00\,(t_s - t_a) = AK\,(t_s - t_a)$$

$$\text{and } K \text{ corrected} = \frac{AK_1 - 1.00}{A} \quad . \quad (2)$$

This correction was verified by tests made on the drums with the water seals heavily insulated with hair felt. The values of K so determined agree closely with the values obtained by applying the correction.

Fig. 3 is a copy of a test data sheet and shows all readings and calculations for one test.

V. Results of the Tests

8. Discussion.—The significance of the tests will be best understood by a study of the information presented in the diagrammatic chart, Figs. 5 and 5a. The heavy black bars afford a graphic comparison of the heat emitting value of the various surfaces. Reference must be made to the descriptive list of drums in order to connect the data with particular test specimens. The relative efficiencies of the various surfaces as heat insulators are given in the next to the last column of the chart. The co-efficient for bright IC tin was used as the basis for this comparison.

The first result of importance is the convincing evidence which the tests present as an argument against the use of thin layers of asbestos paper covering on bright tin pipes. The heat loss was 39 per cent. greater with one thickness of the paper than without. Such a loss is of no small degree of importance as calculations will show that it results in a waste of 5 per cent. or more of the coal consumed in the average house furnace.

The fact that the heat loss from the warm-air pipes of a furnace system is of some consequence is not appreciated generally. A considerable part of the heat of the air flowing through the pipes of the average installation is dissipated from the pipe surface to the surrounding air and nearby objects. The insert in Fig. 6 sets forth the results of tests made to determine the amount of this loss. The tests were carried out on a single leader pipe furnace,* see Fig. 6, in which the quantity of air handled and the heat content of the same above the entering temperature could be readily ascertained. The heat loss was determined by calculation from the drop in temperature of the air in its passage through the pipe. The temperature and velocities indicated in the curves are fair representative values.

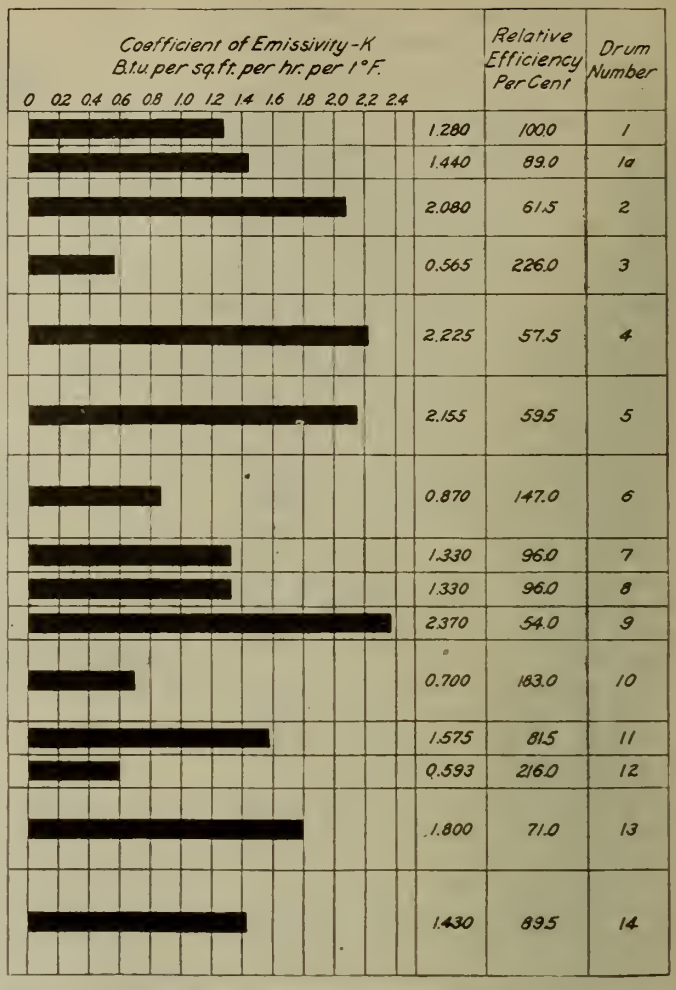
The significance of these preliminary tests is to bring out the fact that the heat loss from warm-air furnace pipes is a serious item. From the curves it can be seen that in the case of the asbestos paper-covered pipes the loss amounts to about 23 per cent. of the heat of the air at the bonnet, above inlet air temperature. If the pipe is of bright tin and not covered this loss is reduced to about 17 per cent. of the heat available. In either case the loss is great; and with the further consideration that a warm-air furnace under average conditions of installation is, at best, only about 60 per cent. efficient, it will be understood that the actual waste of coal ascribable to poor heat pipe insulation is enough to warrant attention.

The attempt was made in the steam drum tests to determine the effect upon the heat loss of having the drum partly enclosed so that free circulation of the air about the drum would be prevented. The experiment simulated the effect of running leader pipes between joists. The results of these tests as shown in No. 14 and No. 14a indicated a slight decrease in the value of K for the enclosed drum.

The argument has been advanced that if bright tin pipes were used without

*University of Illinois Engineering Experiment Station Bulletin No. 112, "A Report of Progress in Warm-Air Furnace Research," by Prof. A. C. Willard.

Drum Number	Description of Surface	Area Exposed to Steam sq. ft.	Coefficient of Emissivity - K B.t.u. per sq. ft. per hr. per 1° F.	Relative Efficiency Per Cent	Drum Number
1	IC tin, not insulated, bright	5.53	1.280	100.0	1
1a	Same as No. 1 with ash dust sifted on $\frac{1}{16}$" deep	5.53	1.440	89.0	1a
2	IC tin with 1 thickness of 10-pound asbestos paper	5.52	2.080	61.5	2
3	IC tin with 3 thicknesses of air-cell asbestos and 1 thickness of 10-pound asbestos paper	5.50	0.565	226.0	3
4	IC tin with 2 applications of gray paint, (of zinc, linseed oil, and lithpone composition)	5.51	2.225	57.5	4
5	IC tin with 1 thickness of asbestos paper and 2 applications of paint, (No. 2 drum with same kind of point as used on No. 4)	5.52	2.155	59.5	5
6	IC tin with 1 thickness of air-cell asbestos and 1 thickness of 10 pound asbestos paper, (No. 3 drum used)	5.50	0.870	147.0	6
7	IC tin nickel plated and polished	5.54	1.330	96.0	7
8	Galvanized iron, No. 28 U.S.S. gage	5.53	1.330	96.0	8
9	Black iron, No. 28 U.S.S. gage, very rusty	5.52	2.370	54.0	9
10	Surface and drum No. 3 with IX tin casing surrounding, with $\frac{5}{16}$" air-space and with 6 $\frac{1}{2}$" vent holes cut in the casing	5.50	0.700	183.0	10
11	IC tin (drum No. 1) coated with Bakelite lacquer	5.53	1.575	81.5	11
12	Same as No. 10 but with vents stopped	5.50	0.593	216.0	12
13	IC tin (drum No. 2) with 1 thickness of 10-pound asbestos paper and a surface of glaze finish printers' proofing paper	5.52	1.800	71.0	13
14	IC tin drum No. 4 with paint removed and a housing of compo-board construction, to represent joists, built around some. Housing 8" deep by 14" wide by 28" long	5.51	1.430	89.5	14



DIAGRAMMATIC TABLE OF THE RESULTS OF 160 TESTS ON STEAM DRUMS

covering, they would soon become fouled with dirt and dust and so rendered less efficient heat carriers than asbestos paper covered pipes. The fallacy of this argument is revealed by tests No. 1a and No. 16a. In these tests fine ash dust was sifted on the test drums, one of bare bright tin and the other asbestos paper covered. The dust was more than one-sixteenth inch deep on top of the drums. The results as shown in tests No. 1a and No. 16a of the chart indicate that the bare tin suffered a loss of 11 per cent. in efficiency whereas the asbestos paper surface improved 2.4 per cent. There still remained, however, a difference of 25 per cent. in favor of the bare tin pipe.

In order to demonstrate further the inefficacy of thin layers of asbestos paper as a heat insulator, tests were run in which the number of thicknesses of paper was increased until the heat loss became less than the loss through a bare, bright tin specimen. The curve (Fig. 7) gives the results of these tests. Eight thicknesses of the twelve-pound paper were applied before the desired result was obtained. In these tests the moistened paper was wrapped tightly and shrunk on the drums so that only a small quantity of air was entrapped between the successive layers of paper. The total thickness of paper was two-tenths of an inch. The impractical features of such a method of insulating are, of course, evident. The use of thin layers of asbestos paper on bright tin pipes must be abandoned if the best results are to be obtained in furnace heating.

Other materials of better heat insulating value than the bare tin were tested. Numbers 3, 6, 10, 12, 15, 18, and 21, all show values which indicate that a large saving would be effected by their use. Some of them are expensive and not easy of application, but good selections may be made. The air-cell combinations Nos. 3 and 6 are excellent insulators, are easy to fit to basement leaders, are not expensive, and the latter, in particular, is not bulky.

The double wall tin pipes Nos. 10 and 12 are very efficient insulators and are easy to construct and to install. Other tests are in progress which are expected to establish still further the merits of this type.

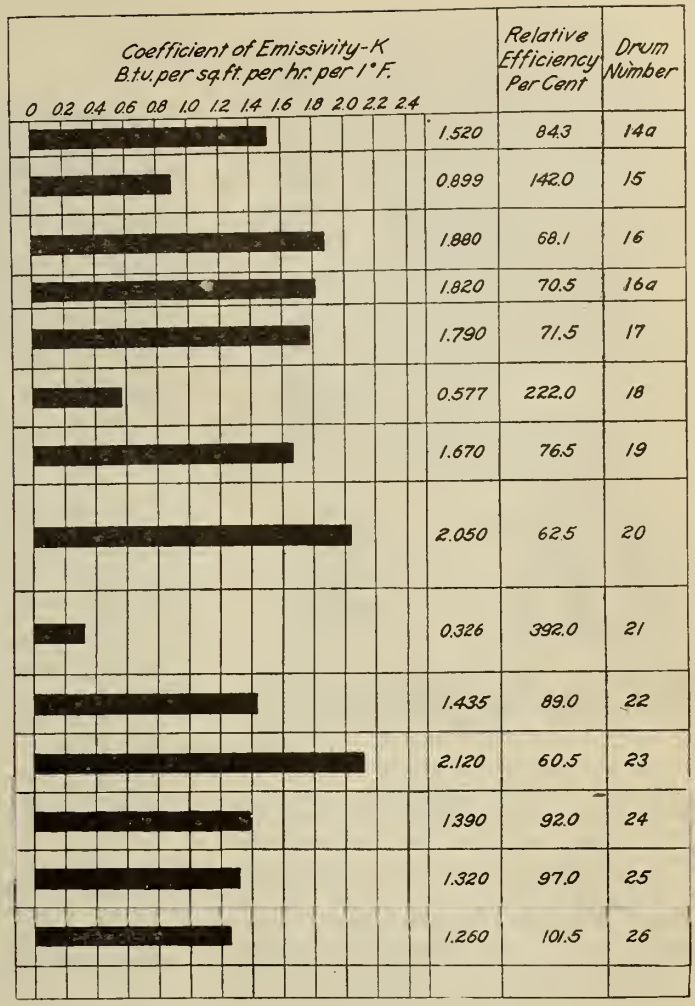
The tests on galvanized iron specimens brought out the fact that the heat loss through this material is not greater than through bright tin of the same gauge. This low heat radiating property is an argument in favor of the galvanized iron leader pipe. Nos. 18 and 21 are good insulations for the exterior of furnace casings, the heat loss through the latter being almost negligible. No. 21 is very easily applied.

The tests on drum No. 11 were made to determine the effect of transparent applications on the tin surface. Bakelite lacquer was used. The result was a slight increase in the heat loss. It was thought that the use of the lacquer would be justified in practice by its rust preventing qualities, but specimens exposed to steam laden air for long periods show no advantage for the protective coating.

Tests Nos. 20 and 23 were made for the purpose of ascertaining the effect of color upon the heat radiating value of a surface. Applications of white calcimine were made on a drum which was tested; then a coat of dull black calcimine was added and the drum re-tested; a final coating of white calcimine was applied and the drum again tested. The alternate tests with white calcimine checked very closely proving that the additional thickness of the calcimine was not sufficient to have any bearing on the results. Beyond demonstrating the superior radiating value of a dark surface, the tests have little significance.

Specimens Nos. 4 and 5 demonstrated the uneconomical effect due to increased heat loss of any kind of oil paint applications on heat pipes. A comparison of Nos. 1 and 4 will show the enormous increase in heat loss caused by painting bright tin heat pipes, and a comparison of Nos. 2 and 5 will show the similar

Drum Number	Description of Surface	Area Exposed to Steam sq. ft.
14a	Same as No. 14 with housing removed	5.51
15	Same as No. 10 but with the air-space packed with dry JM asbestos cement	5.50
16	IC tin with 2 thicknesses of 12-pound asbestos paper	5.52
16a	Same as No. 16 with ash dust sifted on $\frac{1}{16}$" deep	5.52
17	IC tin (drum No. 2) with 3 thicknesses of 12-pound asbestos paper	5.52
18	Galvanized iron (drum No. 8) with 3 thicknesses of air-cell asbestos and 1 of 12-pound paper	5.53
19	IC tin (drum No. 2) with 4 thicknesses of 12-pound asbestos paper	5.52
20	IC tin with 1 thickness of asbestos paper covered with a firm coating of white calcimine, (for determining the effect of light and dark surfaces)	5.51
21	Galvanized iron (drum No. 8) with $1\frac{1}{4}$" Asbestocel blocks covered with $\frac{1}{4}$" of asbestos cement and a cheesecloth wrapper	5.53
22	IC tin (drum No. 2) with 5 thicknesses of 12-pound asbestos paper	5.52
23	Same as drum No. 20 with lampblack calcimine on the surface used in that test	5.51
24	IC tin (drum No. 2) with 6 thicknesses of 12-pound asbestos paper	5.52
25	IC tin (drum No. 2) with 7 thicknesses of 12-pound asbestos paper	5.52
26	IC tin (drum No. 2) with 8 thicknesses of 12-pound asbestos paper	5.52



CONTINUATION OF DIAGRAMMATIC TESTS.

wasteful effect of painting over the asbestos paper covering. However, the use of paint on asbestos paper has in its favor the moisture-proofing effect of the paint.

Other information of value may be found in the data given in the table. To use these data for the determination of the approximate heat loss from a heat pipe, it is only necessary to multiply the value of K for the surface by the surface area of the pipe exposed and further multiply by the difference in temperature between the air inside and outside the pipe, or,

B. t. u. loss per hour = K x Area in sq. ft. x $(t_i - t_a)$

On account of the difficulty of correctly measuring the temperature of the air near the inner surface of the pipe, the method of determining the loss from a pipe as here given is only approximate.

VI. Corroborative Tests

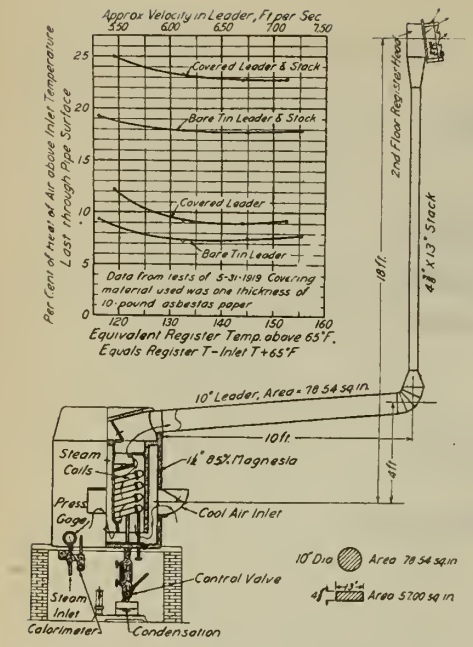
9. The Auxiliary Air Plant.—In order to show the connection between the work done on the steam drums already described and conditions obtaining in a warm-air system, the following account of experiments conducted on the Auxiliary Furnace Plant which is shown in Fig. 6 of this bulletin is given. In these experiments the weight of air flowing up the pipe was determined by the use of the steam-air meter which supplied the heat. Half way along the ten-foot length of the ten-inch leader pipe was located a traversing device (Fig. 8) which made it possible to get temperatures at any point across the pipe diameter by intervals of one-hundredth of an inch. A thermocouple was used in the traverse and its readings were accurate within one degree Fahrenheit. A second couple was tinned to the surface of the pipe and by rotation of the pipe (a short section could be turned) temperatures at any point on the surface in the plane of rotation of the couple could be determined.

10. Temperature Measurement.—The couples used in this work were made of copper and constantan wires of No. 22 gauge. The junctions were silver soldered. Fig. 8 shows the wiring arrangement and the instruments used for two couples. As many couples may be used as there are contact points on the selector switch. Four were used on the leader pipe for the tests here described. The couples were calibrated individually in a hot oil bath over a range of 200 degrees, and calibration curves were carefully drawn. It is possible to repeat readings of the pyrovolter within 0.01 millivolt which by calibration is 0.4 degree Fahrenheit. This insures an accuracy of reading of one-half degree. As the couples were soldered to the surface of the pipe in some parts of the work, it was thought advisable to repeat the calibration after the couples were removed from the pipe. The constancy of the couples was found to be unaltered by the soldering to the pipe.

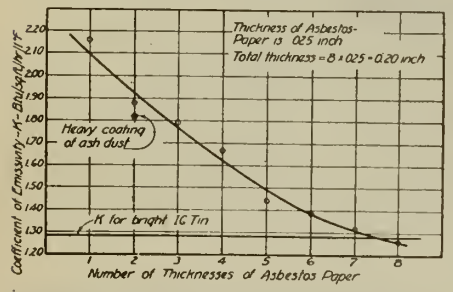
The use of thermometers for accurate temperature measurements in an air stream is not satisfactory. Thermometer readings will not be in agreement with thermocouple readings though both are suspended in close proximity in the same stream of moving air. For this reason thermocouples were used throughout these tests.

In Fig. 9 are given temperature traverse curves showing the variation in temperature across the ten-inch pipe. Curves are shown for both the asbestos paper-covered pipe and the bare pipe, all other conditions of the tests being identical. The curves demonstrate the heat-radiating value of the asbestos paper. Note that not only the air temperature but the surface metal temperature beneath the paper is lower in the case of the covered pipe, this fact indicating that the tin is conducting the heat to the asbestos covering, which in turn radiates it more rapidly than does uncovered tin. Very exact means were

*Paper by J. R. Allen, given before American Society of Heating and Ventilating Engineers, Jan. 28, 1920.


Approx Velocity in Leader, Ft per Sec
550 600 650 700 750
Per Cent of heat of Air above Inlet Temperature Lost through Pipe Surface
Covered Leader & Stack
Bare Tin Leader & Stack
Covered Leader
Bare Tin Leader
Data from tests of 5-31-1919 Covering material used was one thickness of 10-pound asbestos paper
120 130 140 150 160
Equivalent Register Temp. above 65°F.
Equals Register T - Inlet T + 65°F
2nd Floor Register Head
18 ft.
48" x 13" Stack
10" Leader, Area = 78.54 sq in.
10 ft.
4 ft.
Steam Coils
1½" 85% Magnesia
Press. Gage
Cool Air Inlet
Steam Inlet
Calorimeter
Condensation
Control Valve
10" Dia. Area 78.54 sq in
Area 5700 sq in

ELEVATION OF AUXILIARY FURNACE PLANT WITH INSERT SHOWING HEAT LOST FROM COVERED AND BARE BRIGHT TIN PIPES.


Thickness of Asbestos-Paper is .025 inch
Total thickness = 8 x .025 = 0.20 inch
Heavy coating of ash dust
K for bright IC Tin
Coefficient of Emissivity - K - Btu/sq ft/hr/°F
Number of Thicknesses of Asbestos Paper

CURVES SHOWING EFFECTIVENESS OF COMMERCIAL ASBESTOS PAPER FOR INSULATION OF BRIGHT TIN PIPES

WARM AIR FURNACE RESEARCH
ENGINEERING EXPERIMENT STATION
UNIVERSITY OF ILLINOIS

Date 2-17-1920
Name [illegible]

Auxiliary Plant
Subject Temperature Traverse Test of 10" Leader.
10"x10' Leader not covered, to 43"x13"x14' Stack

No.	Inst. No.	Time	Temp. Traverse: Position	Thermocouple Reading	Thermocouple Temp. °F	Room T °F	Air Temp.: Couple Reading	Air Temp. °F	Metal Temp.: Couple Reading	Metal Temp. °F		Weight: Time	Weight: Scales
1			Contact										
2			.01	2.89	156	68	At Bonnet		At Bonnet			Time	Scales
3			.06	3.10	164		3.70	187	2.06	122.5		1.55	3.68
4			.11	3.16	166							2.55	28.62
5			.21	.25	169.5							Diff.	24.94
6			.26	.28	170.5		At 2 Ft. Out		At 2 Ft. Out			St. Press.	137 Lb.
7			.36	.29	171		3.66	185	2.10	124		Barometer	= 29.60 "Hg.
8			.56	.35	173.5								
9			.76	.39	174.5								
10			.96	.42	176		At 5 Ft. Out		At 5 Ft. Out				
11			1.46	.51	179		3.60	183	2.12	125			
12			1.96	.51	179								
13			2.46	.56	181								
14			3.46	.57	181.5		At 8 Ft. Out		At 8 Ft. Out				
15			3.96	3.59	182	68	3.49	179	2.14	126			
16			Contact										
17			.01	3.10	164	68							
18			.06	.29	171		At Boot		At Boot				
19			.11	.34	173		3.42	176					
20			.21	.47	178								
21			.26	.49	178.5								
22			.36	.55	180.5								
23			.56	.58	181.5								
24			.76	.63	183.5								
25			.96	.66	185								
26			1.46	.66	185								
27			1.96	.67	185.5								
28			2.46	.65	184.5								
29			3.46	.65	184								
30			4.46	3.64	184	68							

Traversing Upward
Traversing Downward

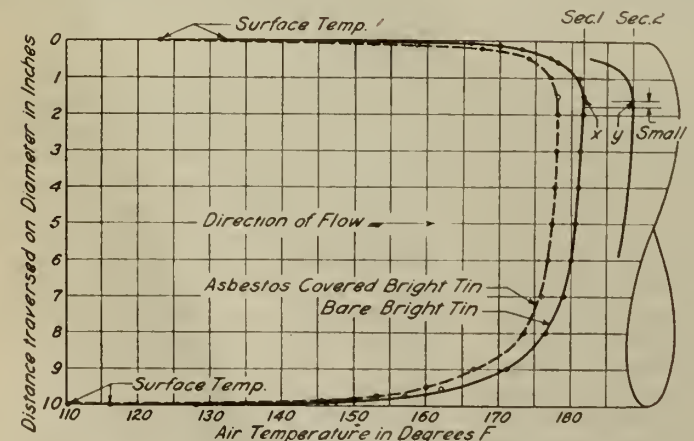
Weight Air per Hr by Steamer = (1188 + 32 - 340) x 0.95 x 24 = 23014. 0.24 x (187 + 68)

Diagram Showing Reading Positions

DATA FOR A TEMPERATURE TRAVERSE TEST ON THE AUXILIARY FURNACE TESTING PLANT.

taken to determine the temperature of the film of air in contact with the inner surface of the pipe. The traversing couple, made of wire 0.025 inch in diameter, was filed flat at the junction so that it was less than 0.02 inch thick. Measurements of the temperature were made with this thin couple at a distance from the pipe surface just great enough to cause a break in an electric circuit through the couple and the pipe, the break being indicated by a small voltmeter in the circuit. The distance was less than 0.01 inch from the pipe surface. The temperatures were found to differ from the metal temperature 15 to 30 degrees, the greater difference existing in the case of asbestos paper-covered pipe. (See the sample data sheet Fig. 10 for data on these measurements.)

The temperature change of the air flowing in the pipe was determined by the use of couples suspended in the air



TEMPERATURE TRAVERSE CURVES OF TEN-INCH LEADER PIPE.

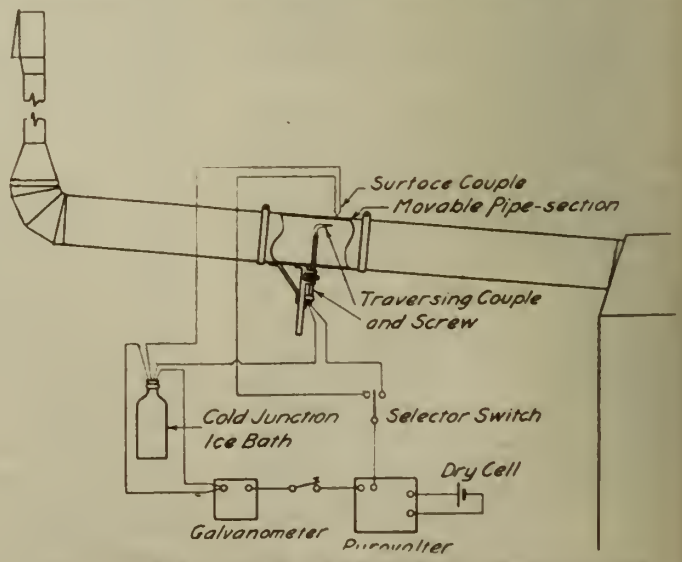


DIAGRAM OF THERMOCOUPLE CONNECTIONS TO THE AUXILIARY TESTING PLANT.

stream three inches below the top of the pipe. These couples correctly register the temperature drop of the mass of air between any two sections for the reason that the traverse curves are similar in shape at all sections along the pipe, and the error in reading the temperature due to a difference in the traverse curve is very slight. This fact is illustrated in Fig. 9 at Sec. 1 and Sec. 2. It will be seen that a great difference in the shape of the traverse curve would be necessary to cause serious error in determining the temperature drop along the path of flow of the air.

In measuring the temperature of the pipe surface it was found that whereas the air in the pipe dropped in temperature, the pipe itself showed a measurable increase in temperature away from the furnace. This slight increase occurred when the pipe was covered as well as when bare. As this increase amounted to only about 3 degrees and was proportional to the length of pipe, it was considered permissible to use the temperature half way up the leader as the mean metal temperature.

11. Calculation.—The co-efficient of emissivity for the pipe surface may be calculated since the heat loss through the surface of the pipe between any two sections is equal to the decrease in the heat content of the air in its passage through the length of pipe between the two sections, or,

$0.24\ W\ (t_1-t_2) = A\ (t_5-t_6)\ K_1 \ldots (3)$

in which W is the weight of air flowing.

t_1-t_2 = the temperature drop of the air in the given length of pipe.

A = the area of the pipe exposed in the given length of pipe.

t_5-t_6 = the drop in temperature between the metal of the pipe and the air.

K_1 = the co-efficient of emissivity not corrected.

Solution of the equation will furnish a value for K_2, which will not, however, check or agree with the value determined in the steam drum tests of the same material. The variation may be easily explained since it is a well-established law that the co-efficient of heat emissivity of a hot body varies with the temperature difference between the heating and the cooling medium. (See tests of radiators by J. R. Allen which demonstrate this fact).

In the case of the heat pipe the temperature traverse showed a low air temperature near the inner surface of the pipe and also a correspondingly low temperature of the metal of the pipe. The result is a comparatively low value of t_5-t_6 and according to the law, a low co-efficient is to be expected.

The following case will illustrate: the pipe was covered with 12-pound asbestos paper. The surface couple showed that the temperature of the tin beneath the paper was actually lower than the temperature in the case of a bare pipe.

TEN SAFETY COMMANDMENTS

1. Thou shalt have no thoughts other than thy work.
2. Thou shalt take no unnecessary risks nor try to show off nor play practical jokes, for by thy carelessness thou mayest do injury which will have effect upon the third or fourth generation.
3. Thou shalt not swear nor lose thy temper, when things do not come just right.
4. Thou shalt not clean machinery while it is in motion.
5. Remember that thou art not the only one on the job and that other lives are just as important as thine own.
6. Honor thy job as thyself, that thy days may be long in employment.
7. Thou shalt not watch thy neighbor's work, but attend to thine own.
8. Thou shalt not let the sleeves of thy shirt hang loose nor the flaps of thy coat unbuttoned, as they may get caught in the machinery.
9. Thou shalt not throw matches or greasy waste on the floor nor scatter oil around bearings, as a dirty worker is also a clumsy worker and a clumsy worker is a menace to his fellow workers.
10. Thou shalt not interfere with the switches, nor the cables, nor the engines, nor anything else that thou art told is dangerous.

An ounce of prevention is worth a pound of cure.

Every man's task is his life preserver.

To live long it is necessary to live carefully.

Doing nothing is an apprenticeship to doing wrong.

$W = 479$

$t_1-t_2 = 17$

$t_5-t_6 = 44$

$A = 26.40$

$$K_2 = \frac{479 \times 0.24 \times 17}{44 \times 26.40} = 1.77 \text{ B. t. u.}$$

per sq. ft. per hr. per 1 degree F.

Assuming that the correction of 0.1 per cent. per degree F. below the standard range of 150 degrees which is used in making corrections with direct radiators applies to this surface,* the value of K becomes:

$K_6 = K - 0.002\ K\ [150 - (t_5-t_6)]$

$1.77 = K\ [1 - 0.002\ (150 - 44)]$

$K = 2.24$ B. t. u. per sq. ft. per hr. per 1 degree F.

This result is in close agreement with the value of K = 2.08 as determined in the steam drum tests and reported above.

12. Conclusion.—Enough tests have been made on this apparatus to entirely corroborate the results obtained on the steam drums, and additional tests are in progress in which more exacting methods are employed.†

*"Mechanical Equipment of Buildings," by Harding and Willard, vol. 1, p. 78.

†For further information regarding the tests involving the use of thermocouples on this plant, see University of Illinois Engineering Experiment Station Bulletin No. 112, "A Report of Progress in Warm-Air Furnace Research," by Prof. A. C. Willard. An abstract of this bulletin was presented at the Annual Meeting of the American Society of Heating and Ventilating Engineers, at New York, January 28, 1920.

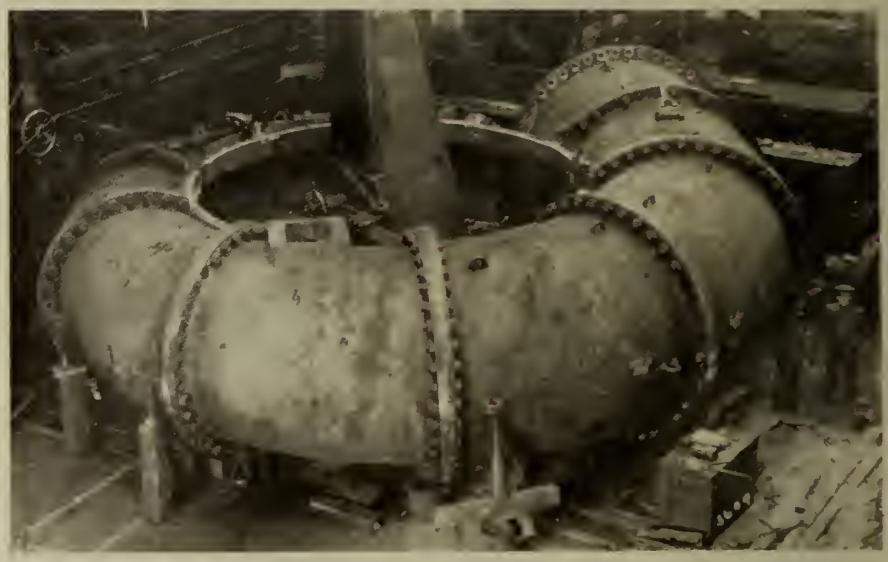
By means of a method of chemical analysis, in which the electric arc is utilised, Mr. W. R. Mott, an American research chemist, claims to identify readily about sixty-five elements, picking them out from their ores, compounds with oxygens, or alloys. According to the Chemical Trades Journal, the apparatus required is simpler than that for spectroscopic analysis, and includes a carbon arc lamp so enclosed as to project upon a screen an image magnified 20 diameters. A half-gram sample of the material to be tested is placed in a cup-like cavity, two-fifths of an inch wide and deep, hollowed out of the positive lower carbon of the pair. The elements are recognized by various phenomena, including the nature and colors of the material deposited on the carbon pole from distillation, the smoke, sparks and flame-tip color shown, and the odor of the fumes emitted, with many other peculiar characteristics. The smoke emitted from the hot upper carbon when the arc is broken appears only when molybdenum is present, being a delicate test for that element. The present of calcium is shown by its peculiar red color, and characteristic odors reveal iodine, arsenic, and tungsten. Many elements difficult to determine in other ways are said to be clearly identified by this new system.

D. M. McLean, formerly chief engineer of the Dover Boiler Works, Dover, N. J., general sales manager of the L. & I. J. White Company, Buffalo, N.Y., etc., and for the past four years manager of the publicity department of the Canadian Ingersoll-Rand Company, Sherbrooke, Quebec, recently left the latter company to assume control of C. & C. Limited, Rock Island, Quebec, manufacturers of fancy biscuits and candies. Mr. McLean's son, F. A. McLean, A.M. C.M.I., and formerly with the Crocker-Wheeler Company, Lackawanna Steel Company, McKiernan Terry Core Drill Company, etc., and latterly general assistant publicity department Canadian Ingersoll-Rand Company, has been appointed as his successor.

The Hydraulic Turbines for Niagara Falls

Each of These Machines Will Develop 61,000 B.H.P. at 187½ R. P. M.—They Will Be Coupled to 45,000 K.V.A. Vertical Generators—The Turbine Casing Weighs 110 Tons

IT is quite natural that the most powerful hydraulic turbines should be installed to generate power at Niagara Falls, the sight of which impresses the most casual observer with their immense power possibilities. The Ontario power plant at the foot of the Canadian Falls is now controlled by the Hydro-Electric Power Commission of Ontario and is the largest plant on their system. This plant has sixteen hydro-electric units with a total capacity of 240,000 H.P. The head available at this plant is only 180 feet. By carrying the same amount of water on the Welland River four and one-half miles, thence through a nine mile canal skirting around the corporate limits of Niagara Falls, Ontario, to a point near Queenston, the Hydro-Electric Power Commission will increase the net effective head on the turbines to 305 feet and obtain 70 per cent. more power with the same quantity of water. This development will provide the most economical and efficient use of the available water at Niagara. Water will be taken at a point two miles above the Falls at practically the same elevation as Lake Erie and will be discharged into the river one-half mile from Queenston at about the level of Lake Ontario. The canal will be 48 feet wide by 35 feet deep in rock cut and 70 feet wide by 35 feet deep in earth cut.



MACHINING OF S.C. SPIRAL CASING FOR 52,500 H.P. SINGLE VERTICAL TURBINE.

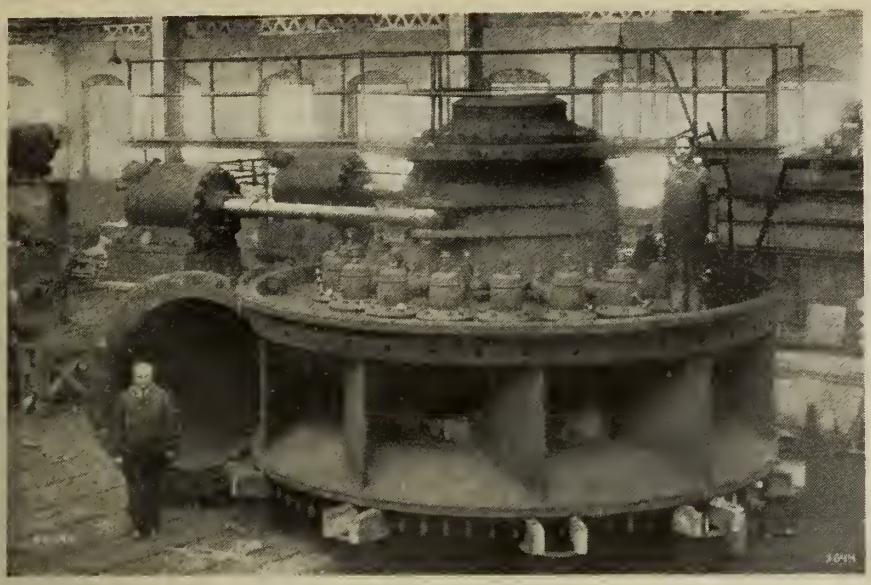
The Power House

The power house is located at the foot of the cliff at the end of the canal which terminates with a forebay in front of the intake gate house. The water is conducted to each turbine through a 14-foot diameter plate steel penstock about 450 feet long. As the system which this plant supplies is one of the largest on the continent, the capacity of the units was made as great as present practice in hydro-electric units would warrant in order to minimize the number of units. Each turbine at full gate will develop 61,000 B.H.P. at 187.5 R.P.M., and it is intended to operate each machine at from 47,000 H.P. to 55,000 H.P. through which range the highest efficiencies occur. The weight of the turbine equipment is 625,000 pounds exclusive of the governor apparatus. The turbines will be coupled to 45,000 K.V.A. vertical generators being built by the Canadian-Westinghouse Company, Ltd., at Hamilton, Ontario.

The first two turbines for this installation have been designed and are being built by the Wellman-Seaver-Morgan Company of Cleveland, Ohio, who are especially well equipped to make the large steel castings and machine the large sections necessary in units of this type.

The turbines are of the single runner vertical type with downward discharge into a single draft tube. The water is distributed around the circumference of the turbine through a cast steel spiral or scroll casing having approximately circular cross sections. It is then guided to the runner and the velocity increased through the cast steel speed ring and gates. The stationary vanes of the speed ring form the tie across the throat opening of the spiral casing and also to withstand the hydrostatic pressure inside the casing and also to transmit part of the load of the concrete and generator above. The inlet diameter of the spiral casing is 10 feet and the distance across the casing at the widest part is about 38 feet. From the center to the extreme edge of the inlet flange is 22 feet. The casing was made in nine sections. When bolted together with the speed ring the casing was subjected to a very satisfactory shop test of 260 pounds per square inch water pressure which is over double the normal working pressure. Measurements taken during the test showed that all parts safely withstood this test with-

SECTION OF SPIRAL CASING ON BORING MILL.



ASSEMBLY OF TURBINE SIDE VIEW.

out any excessive strains being set up in the castings or bolting. Figure 1 shows the casing set up in the shop for the pressure test.

In order to secure castings to safely withstand this test pressure the various sections were cast on end so that all impurities would float out into the risers, leaving the metal perfectly sound. The moulds were made in green sand and with a green sand core. In making up the mold the core was rammed up inside the skeleton pattern which was then taken off and the core smoothed up. The pattern was again placed around the core, the flasks put in place, rammed up, then removed and smoothed up on the inside. The pattern was finally removed and both the core and flask dried out to insure a hard surface for the mold. The flasks were arranged with a parting midway of the height of the mold to facilitate removal and replacing them. The castings obtained were very uniform in thickness and exceptionally sound in every respect. The tests of the metal ran from 70,000 to 85,000 pounds per square inch tensile strength and the elastic limit from 40,000 to 52,000 pounds per square inch. The largest section of the casing weighed 37,000 pounds—the whole casing weighing slightly over 110 tons.

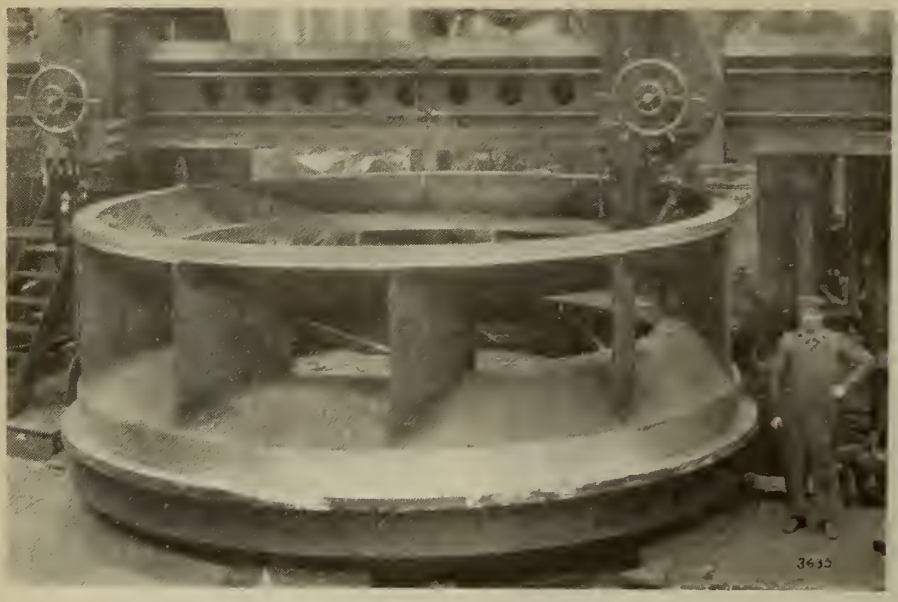
To facilitate the machining of the individual sections of the casing at the radial joints, six of the sections were designed to subtend an angle of 36 degrees. This feature permitted each of these sections to be set up on an inclined fixture mounted on a large boring mill so that the upper surface could be faced off horizontally, the casting then turned over and the other flange faced. After facing off the ends of the sections were drilled, bolted together and set on supports around the table of a large boring mill. The vertical housings of the mill were moved back and the tool post bolted to the table of the mill in order to machine the inner faces to which the speed ring is bolted.

One of the runners for these turbines is shown in Figure 2. It is made of steel cast in one piece and weighs 33,000 pounds. Extreme care is taken in setting the cores for this casting as the water passages and vanes must be uniform, smooth and true to design in order to secure high efficiency and to preclude corrosion. These runners when completed are accurately balanced and great care is taken in truing up the runner and shaft to insure perfect operation. When running at 500 R.P.M. no vibration whatever could be measured.

The turbine is so designed that the runner may be disconnected from the flange coupling on the end of the main shaft and removed from below the turbine casing without dismantling the generator or disturbing the alignment of the unit.

The main shaft at the coupling end is 30 inches diameter and through the bearing it is 31 inches diameter. It is hollow bored to 8 inch diameter throughout its length of 22 feet 3 inches, in order to pass a cable through for handling the runner and removable draft tube when dismantling by use of the crane in the generator room. On account of the flange being 53 inches diameter at the generator coupling and 51 inches diameter at the turbine coupling it was necessary for the Midvale Steel and Ordnance Company to forge these shafts from 63 inch octagon ingots weighing 122,000 pounds. The finished shafts weigh 54,200 pounds.

125" DIAMETER STEEL RUNNER.



CAST STEEL SPEED RING FOR 52,500 H.P. TURBINE.

The gates are made of steel with the stems cast integral with them and are machined all over, which insures a proper guide for the water with a minimum of friction. The cast steel levers on the ends of the gate stems are connected to the cast steel operating ring by cast iron links. These links are designed to break before the elastic limit of any of the other parts of the gate mechanism is reached.

Two 24 inch x 15 inch governor cylinders, bronze lined to prevent rusting, are used to operate the gates of each machine. They are connected to the operating ring by 6¼ inch diameter piston rods. The operating fluid for the governor pressure system will be a mixture of water and a small amount of oil. In case of emergency the governor system can be connected through strainers to penstock pressure.

Every hydraulic feature has been carefully studied to develop the highest attainable efficiency. In the mechanical design the aim has been to obtain strength, ruggedness and simplicity throughout to insure satisfactory and continuous operation. Completely erecting the turbine in the shop will preclude any unnecessary fitting or machine work in the field.

William Beardmore and Company, of Scotland, have opened a Canadian office at 385 Beaver Hall Hill, Montreal. This firm carries on an extensive business in many lines of engineering activity, manufacturing steel shaftings and forgings of all sizes types and axles, small tools, jigs and fixtures, locomotives of every description, lapwelded furnaces and flanging work of all kinds. They are builders of steam, turbo, Beardmore-Tosi, Diesel and Beardmore crude oil engines, centrifugal and semi-rotary wing pumps. They are also naval constructors, having built H. M. S. Raleigh and other war vessels.

31 AND 30 INCH DIAMETER SHAFT.

OBITUARY

Mr. F. C. Harding, secretary of the Toronto No. 1 Lodge, C.A.S.E., and chief engineer of the Christie Street Hospital, died as a result of asphyxiation by carbonic acid gas. Mr. Harding was running his automobile engine in an enclosed garage and the gas evidently accumulated without notice by him, until it mounted high enough to be drawn into his lungs. The sympathy of all members of the C.A.S.E. and of Power House is extended to Mrs. Harding.

The death occurred on January 7 of Edward G. Little, engineer of the local Hydro power plant, at Erindale, Ont.

Charles W. McGuire, manager of the Imperial Oil Co., London, Ont., died on January 9th at his home, 799 Hellmuth avenue, following several weeks' illness from heart trouble. Mr. McGuire was one of the most prominent Masons in Western Canada.

Mr. J. M. Fairbairn, chief engineer of the Canadian Pacific Railway, is to be installed as president of the Engineering Institute of Canada at the annual meeting of the organization, which will be held in Toronto during the first three days of February. Mr. Fairbairn is a graduate of the School of Practical Science, Toronto University, and joined the C. P. R. in 1899 as assistant engineer in the construction department.

The Hydro Commissioner for Hamilton, Mr. Guy Long, announced after the first meeting of the year that there was power available for either domestic or commercial purposes, the commission having 3,500 H. P. which they wished to dispose of. Mr. Long did not think that there would be any power shortage this year.

At a meeting of the Scarboro' Township Council, the proposed waterworks were up for discussion. Tenders were received for $130,000 waterworks debentures. The township clerk and the public utilities commissioners have had a conference with the York County Engineer, Mr. A. E. James, with reference to the project, and preliminaries have been commenced. It is hoped to go ahead with the job.

The City of Calgary is using lignite slack for the production of power in their turbo electric station. The slack only costs 25 cents at the mines, and about $2.30 a ton on the plant. This compares with a cost of $7.67 per ton for bituminous slack. An average of .368 cents per kilowatt hour was obtained. The average consumption was 4.46 per kilowatt hour, the lowest being 3.47 pounds and the highest 5.77 pounds. A matter of pride to the electric power force of the city is the fact that there has been no shut down of power in the centre of the city for three years. This is a creditable record.

Another Fatal Boiler Explosion

ONE of the most important duties of a fireman or engineer in a boiler plant is to keep the water in the boiler at the proper level; and it is particularly important to see that there is sufficient water in the boiler before starting up the fire after it has been banked for the night or over a holiday. Failure to take this precaution was probably the cause of the explosion which is described and illustrated in this article, and as a result of which two men were killed and five others were injured. The explosion also caused damage to the surrounding property to an amount estimated at from $7,000 to $10,000.

The exploded boiler was of the horizontal return-tubular type, and was built in 1904. It was 72 inches in diameter and 16 feet long, and contained 80 tubes each 4 inches in diameter. The longitudinal seams were of the lap-joint type, and a working steam-pressure of 100 pounds per square inch was allowed on the boiler.

THE BOILER ROOM AFTER THE EXPLOSION.

We are informed that the man in charge of the boiler arrived at the plant on the day of the explosion at about 5.30 a.m.; and soon after this, aided by some other employees, he proceeded to start up the fire which had been banked over night. When he had worked for about half an hour without being able to raise more than a few pounds pressure (as shown by the steam gauge), the engineer, apparently for the first time, looked at the water gauge-glass and discovered that no water was visible. He then attempted to start the feed-pump, but found difficulty in doing so on account of the low steam-pressure. He therefore returned to the front of the boiler, intending to haul the fire. Just at this moment one of the factory employees, who was in the boiler-room, called attention to the fact that the steam gauge registered a pressure of 80 pounds, and almost immediately thereafter the boiler exploded. The setting was demolished and the walls of the room were badly damaged. The rear end of the boiler was moved about four feet to the right, and the front end about six feet in the same direction.

Seven men were in the boiler-room when the explosion occurred. Two of them died from the injuries received, another was seriously hurt, and the remaining four men escaped with only slight injuries.

The master mechanic of the plant arrived on the scene about twenty minutes after the explosion, and he is said to have stated that at that time the boiler and the tubes were still red-hot.

A subsequent examination of the wrecked boiler showed evidence of overheating in all the tubes, and in that portion of the shell exposed to the fire. The soot was all burned off these parts, and the metal had the appearance characteristic of overheating. A rupture extended the entire length of the middle course, and the edges of the break were drawn down very thin. A second opening about four inches long was found near the large rupture, and for several feet from each end of this opening the metal was stretched almost to the breaking point.

This accident emphasizes several facts of importance in connection with the safe operation of steam boilers. First, it shows the need of observing the gauge glass, and testing the water level by trying the gauge cocks before stirring up the fire. It also demonstrates the danger of starting the feed pump when the gauge indicates that the water has fallen below the safe working level.

At such a time the natural impulse is to pump more water into the boiler as quickly as possible; but this practice is distinctly dangerous and should never be followed. The violent strains caused by the chilling action of cold water on the overheated metal, when added to the stresses already existing in consequence of the pressure in the boiler, are quite likely to cause something to give way. Hence the thing to do when low water is observed is to cool off the boiler gradually, and with as little disturbance as possible.

To avoid accidents due to low water in boilers we recommend to all boiler attendants that the following suggestions be kept in mind constantly:

Before starting up in the morning, make sure that the gauge glass shows the water to be at the right height. Blow down the water column next, and see that the water promptly returns to its proper level when the blow cock on the column is closed again. Try the gauge cocks also, and see that the water level as indicated by them agrees with that shown in the glass.

If the water is low, do not introduce feed-water, and if the feed pump (or injector) is running, stop it immediately. If the boiler is one of a battery, shut off the feed pipe running to it, and close the stop-valve in the steam pipe leading from the affected boiler to the steam main. As soon as these things have been done, cover the fire with a thick layer of ashes. If ashes are not handy, or if there is but a small quantity of them available, shovel in fresh coal, taking care to cover the fire at every point, until the boiler is effectively screened from the hot fuel on the grates. It is far better to bury the fire in this way than to haul it out of the furnace, because a great deal of heat would be given off to the boiler before the hauling could be completed.

Remember that the boiler has shown its ability to withstand the stress under which it was operating when the water was found to be low, and proceed on the theory that the thing to do is to reduce this stress gradually and without any sudden change of any kind whatever.

—*Travellers Standard.*

The Federal Engineering Co., Ltd., 127 John Street, Toronto, have arranged with the Thomson Gordon Co., Hamilton, for the latter to act as their distributing agents in Hamilton and vicinity for Scandinavia and Lanco Balata Belting. The Thomson Gordon Co. will carry a stock of these beltings in Hamilton.

A Course of Instruction for the Graded Certificate

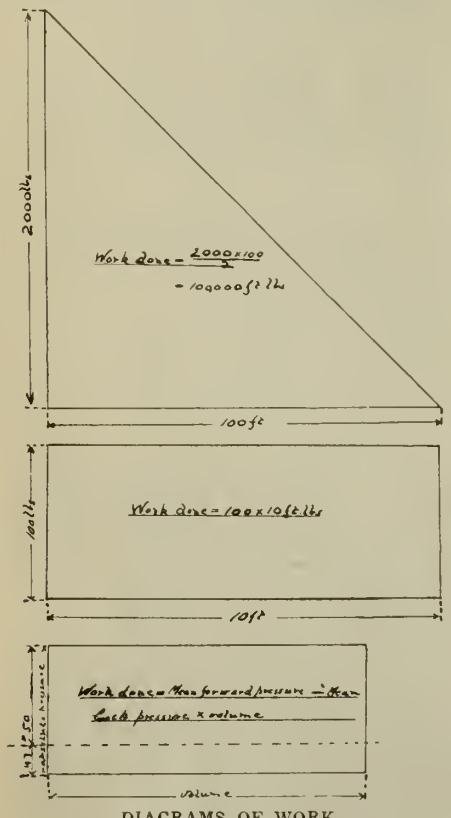
We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE have seen how steam expands according to Boyle's law that pressure multiplied by volume is always a constant to a certain extent. We can now go on to explain the diagram of work, and its application to the action of steam on the piston of an engine.

The Diagram of Work

It has already been explained that work is the product of force by the displacement of the force, or the distance through which the force acts. That being the case, the amount of work done by a force can be represented by a diagram, in which the vertical ordinates represent force, and the horizontal lines



DIAGRAMS OF WORK.

distance. For instance, if we have a force of 100 lbs. acting through a distance of 10 feet the product of force by distance will represent 1,000 foot lbs. If we now draw a line to scale representing 10 lbs. vertically and another to scale representing 1,000 feet horizontally and complete the parallelogram, the area enclosed will be equal to 1,000 ft. lbs., as shown by the illustration. If the force is not a uniform one, but varies from the beginning to the end of the displacement, the diagram may become curved or triangular. Suppose we had a chain

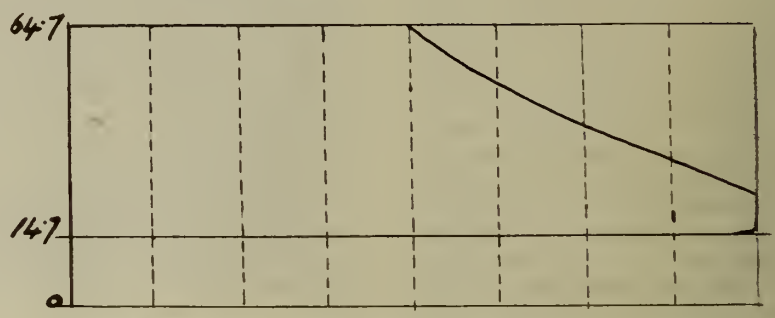


DIAGRAM SHOWING EFFECT OF CUT OFF AT HALF STROKE

that weighed two thousand lbs. and was 100 feet long, hanging vertically, and had to haul it up to the level of the top of the chain. The centre of gravity of the chain would be at a point 50 feet down, and the work done in lifting the whole chain would be 50x2,000 lbs., or 100,000 ft. lbs. Suppose the chain to be lifted 10 feet, the work done would be 2,000 plus 1,800, divided by 2, which would be 1,900x10, or 19,000 foot lbs. The next ten feet the weight lifted would be 1,700 lbs. and the work done 17,000 lbs. This is because, although when we start to lift the weight is 2,000 lbs. the weight decreases uniformly as the chain is hauled up. If we then take an average between the weight at the start of the lift and the weight at the finish and multiply by the height lifted we get the work done at any desired amount of lift. Thus if we take the two extremes we have 2,000 x 0 divided by two gives 1,000, and this multiplied by the lift is 100,000 ft. lbs. The diagram representing this would be a triangle, and the area would, of course, be the base multiplied by half the height. In the case of steam expanding in a cylinder the pressure is varying throughout the stroke in such a manner that the diagram becomes a figure with irregular curved sides, and the area is found by taking a mean of the various heights of the ordinates drawn to meet the curve from the line of zero pressure. If we take a diagram from a pump cylinder or a non-expansive engine the diagram is almost a parallelogram, but where we have steam cut off at any time before the end of the stroke, we get the curve due to the expansion of steam according to Boyle's law. If the height of the ordinates, that is the average height, represents pressure, this will be the mean effective pressure on the piston, and as the length of the indicator card represents the stroke of the engine to another scale, the diagram represents force displacement, and its area the work done, in foot lbs.

The Indicator Diagram

We can now take up the study of the indicator diagram and will take in the first place a diagram from a non-expansive engine, exhausting into the atmosphere. The vertical lines represent pressure, and the horizontal lines volume. Suppose that we have a cylinder taking steam at 50 lbs. gauge pressure and carrying it the full length of the stroke, when the exhaust passage opens and allows the steam to escape. If the stroke of the piston is two feet and the diameter of piston 11.27 inches, which is equal to 100 square inches area, we will have a force of 50 lbs. x 100, or 5,000 lbs., acting through a distance of 2 feet, and the work done will be 10,000 ft. lbs. Now we have said that the gauge pressure is 50 lbs., and as we always measure pressure from the zero line the absolute pressure would be 64.7 lbs., acting on the piston. As we are exhausting against the atmospheric pressure the actual effective pressure will be 64.7—14.7 or 50 lbs. We will see later more exactly how the mean effective pressure varies according to the amount of back pressure during the exhaust stroke of the piston.

Now, suppose we take the same engine and cut off the steam after the piston has travelled, say, half the whole stroke. The steam used will be only half that of the previous example, when it was carried throughout the whole stroke. Let us see how the work done will compare. In order to do this we must construct the theoretical curve of expansion and find by erecting ordinates the average pressure throughout the stroke, or else we can ascertain it by the calculation of pv equals constant. We can do the latter easily, and we find, if we divide the card into 8 parts, that the product of pv at half stroke will be 64.7 x 4, or 258.8. At the next point after cut-off the pressure will be 51.76, at the 6th point 43.13, at the 7th point 36.97, and at the 8th point 32.35. Adding these together and dividing by 8 we get the average

pressure throughout the stroke of 52.81, and subtracting from this the back pressure we get 38.17 as the mean effective pressure. The work done will be 38.17 x 100 x 2 = 7,634 ft. lbs. Thus we see that by cutting off at half stroke we have obtained for just half the weight of steam more than three-quarters the amount of work. We must not run away with the idea from this that expansion can be carried to extreme limits with benefit, because if we cut off so early in the stroke that the pressure falls below the atmospheric line in a non-condensing engine, then the piston will have to perform work against back pressure before reaching the end of its stroke, or in other words, the area of the diagram will be reduced. Suppose we take an instance: Taking again the same cylinder let us cut off the steam at one-eighth stroke. The result will be that the expansion curve will drop below the atmospheric line before the piston reaches the end of the stroke, and that

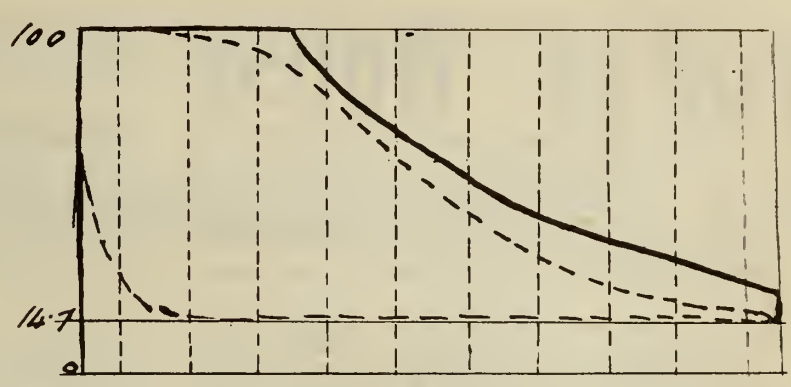


DIAGRAM SHOWING DIFFERENCE BETWEEN ACTUAL AND THEORETICAL CARD.

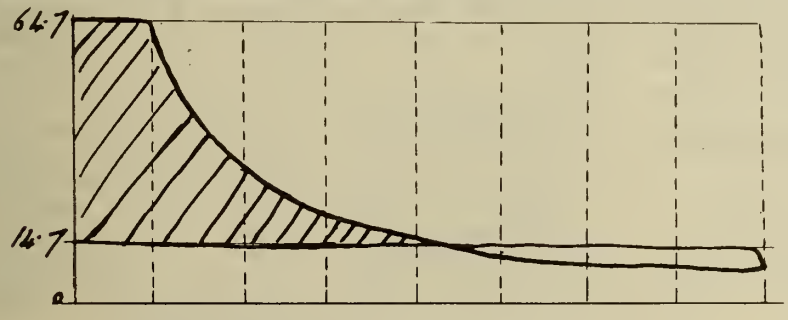


DIAGRAM SHOWING EFFECT OF TOO EARLY CUT OFF.

much work will be negative, as shown on the accompanying diagram.

The actual diagram taken from an engine is not only a means of finding out the work done per stroke, but is also a guide to the distribution of the steam in the cylinder, and the four leading points of that distribution. These are admission, cut-off, release, and compression. These four points are controlled by the movement of the slide valve, and the position of their occurrence tells us whether the valve is set correctly or otherwise. We will deal with valve setting and the different types of valve gears in another article.

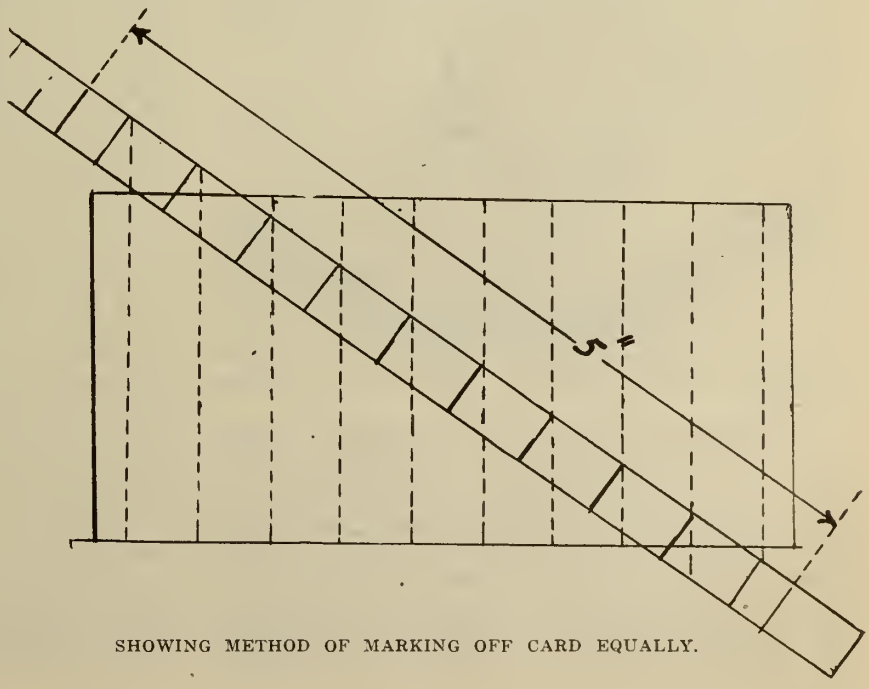
The form of the actual indicator diagram will differ considerably from that of the theoretical diagram, as instead of the sharp corners we shall have rounded corners, and the curve of expansion will fall below that of the theoretical curve. The degree of rounding at the corners of the card will depend on the setting of the valve and the form of valve gear used. The degree of closeness achieved by the actual curve to the theoretical curve will be affected by the degree of moisture in the steam.

In measuring the card for the mean effective pressure it is usual to divide the card into ten equal parts and measure the effective pressure at each point, add the results together, and divide them by ten. The mean effort on the stroke will be the result of the mean effective pressure multiplied by the area of piston and the length of stroke. On the crank side the area of the piston rod is sometimes deducted from the area of piston, but unless very exact results are to be obtained, this is not necessary. The mean effective pressure multiplied by area of piston and stroke gives the foot pounds of energy and this multiplied by twice the number of revolutions per minute gives the work done in foot pounds per minute. This divided by 33,000 gives the horse power. This is usually expressed by the formula

$$\frac{PxLxAxNx2}{33000} = H.P.$$

where P = Mean effective pressure.
L = Length of stroke in feet.
A = Area of piston in square inches.
N = Number of revolutions per min.

A good way of obtaining the divisions on the card is to extend the lines at each end up and down, and lay a rule diagonally across the card, making the points where the line touches the rule exactly five inches. Then make a mark ¼ inch from the line, and the others ½ inch apart over the five inches. By dropping perpendiculars from these marks the card will be accurately divided. The illustration will make this plain. This subject will be continued in further issues.



SHOWING METHOD OF MARKING OFF CARD EQUALLY.

In New Office.—The Delora Smelting & Refining Co., Ltd., manufacturers of Stellite tools and cutting metal, are now in the new office, 1404 C. P. R. Bldg., Toronto. In future all shipments will be made direct from Delora, Ont. Sales and service departments remaining in Toronto.

POWER HOUSE

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AN interesting paper on the commercial possibilities of peat as a fuel was read recently before the Engineering Institute in Toronto, and some of the facts brought to light are of deep interest in view of the general fuel situation. The author of the paper was Mr. Wynne-Roberts, and deals with the formation of peat generally, and with the methods adopted by the Peat Committee, a body appointed by the Government of Canada and the Government of Ontario conjointly.

Peat is produced by the slow decomposition of vegetable matter in the presence of water, and the exclusion of air. The peat as it is found in the natural state in the bog is a mixture of water and disintegrated vegetable matter of varied origin and the weight of the water is from 87 to over 90 per cent. of the total weight of the matter. It is this large water content which presents the greatest obstacle to the utilization of peat as a fuel and the work of the committee has been directed along the lines of discovering a means of drying the peat so that it could be commercially handled. That is where the cost of drying would not exceed the value of the fuel as a heating medium.

It is pointed out that peat is an exceedingly variable substance, as not only will there be a difference between two adjacent bogs, but there will be variations in the different layers of the same bog. These variations, while not affecting the peat as a fuel generally, will affect it when it is to be used for some specific purpose. With increase in age and depth of the bog these differences become less and finally disappear completely. This variation is noticed in the specific gravity of the peat found, which ranges from 0.1 to 1.06. The higher specific gravities occur of course where the peat is more thoroughly decomposed. Another feature is that the ash content, although usually low, may in some cases be so high as to render the peat valueless as fuel. The normal peat does not present any great difficulty as far as ash is concerned. A typical analysis of Canadian peat gives carbon 56 per cent., hydrogen 5.2 per cent., ash 6 per cent., and the oxygen, nitrogen and sulphur make up the balance 32.8 per cent. The calorific value of dry peat is from 8,000 to 9,000 B.t.u. per pound in Canada, though in other countries, notably Ireland, it runs up to 10,000 B.t.u. These values of course apply only to dry peat and as this is never available it is only the net calorific value than can be reckoned on.

The paper points out that various methods have been tried of drying the peat out, one of the first of these being the "Ekenberg Wet Carbonizing Process," in which process the peat was heated under pressure in a closed retort. This effects a chemical change, the carbon content being increased while the free oxygen combines with some of the hydrogen, forming water and thus increasing the water content. As no gases are evolved during the heating, none of the combustible components of the fuel are lost. The peat is then subjected to pressure, when some of the water is separated, and the remaining water has to be separated by artificial heating. In the opinion of the author, this process is not commercially possible. Efforts have been made to separate the bulk of the water by artificial drying, by direct application of heat, or by the passing of heated air over and through the mass of peat to be dried, or again by blowing large quantities of air at atmospheric temperature through it. None of these methods are successful, because there are not enough heat units in a pound of peat containing 90 per cent. water to evaporate the water alone (assuming a drier efficiency of 100 per cent.). Before drying by the application of artificial heat, or by any method whatever, can be attempted, the water content must first be reduced to 50 per cent. or below. If it be reduced to 50 per cent., then for every ton of wet peat containing 200 lbs. combustible substance and 1,800 pounds of water, 1,600 pounds of water must be removed by other means than the employment of artificial heat.

The method now being employed by the Peat Board is known as the wet process and the peat obtained is termed machine peat. In this method the peat is first cut by a machine and afterwards transported to the hopper of a second machine which grinds it down to a fine pulp. This pulp is then taken to a specially prepared portion of the bog and spread over the surface where it is left for the sun and wind to dry it. When sufficiently set the peat is cut transversely and longitudinally into blocks, which when containing 25 per cent. to 30 per cent. moisture, have the dimensions of ordinary building brick. Peat made in this manner is clean to handle and can be burned in an ordinary stove or fireplace with little soot or ash. The ash is finely divided and no clinkers are made, while the fuel is very easy to ignite. For the production of steam the water content should not exceed 30 per cent., and 25 per cent. will give the best results. If the peat is to be manufactured into briquettes it should be dried down to 15 per cent. or lower. The author in concluding his paper draws attention to the large area of peat bogs that are in existence in Europe and on this continent. Canada has 37,000 square miles covered by peat bogs, a large portion of which is suitable for making fuel. In the more inhabited parts of the Dominion there are 12,000 square miles and assuming that this 12,000 square miles has an average depth of 6 feet, there would be sufficient peat to manufacture 9,000,000,000 tons of 25 per cent. moisture peat.

There can be no question that the possession of such large areas of potential fuel has an important bearing on the fuel question in general. The work that the peat committee is doing has a great value to the province and the Dominion in general and is deserving of every sympathy and support. The paper of which such brief extract is given above is crammed full of interesting information on this interesting subject and should be read by all those who have thought or are thinking of the fuel question in a serious manner.

The Operators' Point of View

Methods of Ice Protection For Turbo Hydraulic Plants

By F. SWEET

TO start now and preach preparedness for ice troubles for the winter of 1922 is hardly untimely.

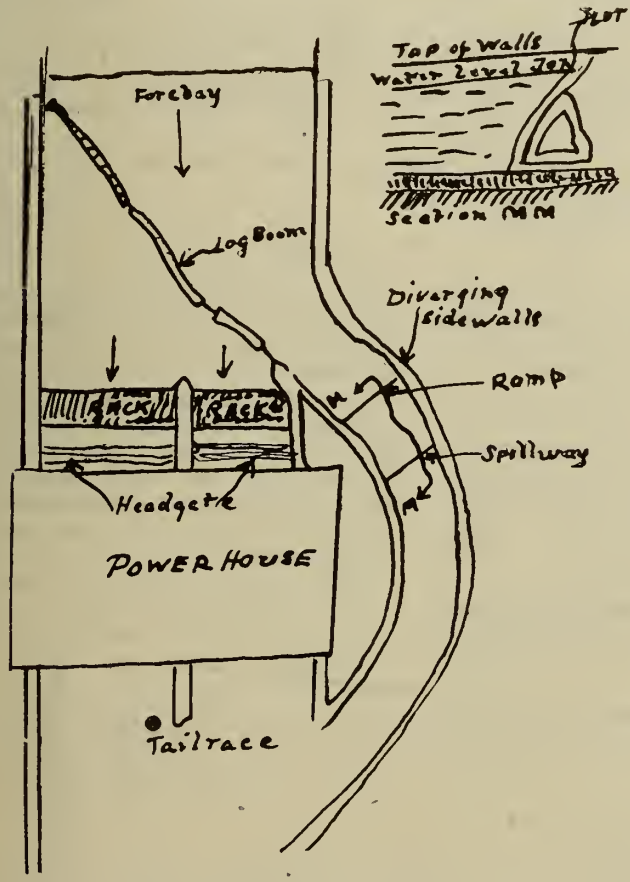
To be brutally frank about it, all such preparations should be fully completed before Labor Day especially if any concrete work be included in the program. Eleventh hour work and repentance are both dangerous, the former where it involves concrete for ice protection, because the concrete does not have the necessary time to age and attain safe values of strength. This last remark concerning strength may appear a trifle dubious or far-fetched to some, but those who have seen what tremendous forces are met with in comparatively small ice jams and have seen the effects produced, will not be inclined to minimize the element of safety.

The field of this article is ice protection for the small and medium sized plant. As a rule the larger plants are provided with suitable means of protection when they are being designed, and such design is usually placed in the hands of competent engineers. Smaller and medium sized plants are usually built first and designed later. The owner often does his own engineering, drawing on his rich experience of perhaps thirty or forty years in human nature, and like the translator who learned his Spanish from cigar bands, he "gets by" somehow. So it is usually after a hard winter's tussle with ice troubles that some earnest thought is given to "what we'll do for next winter."

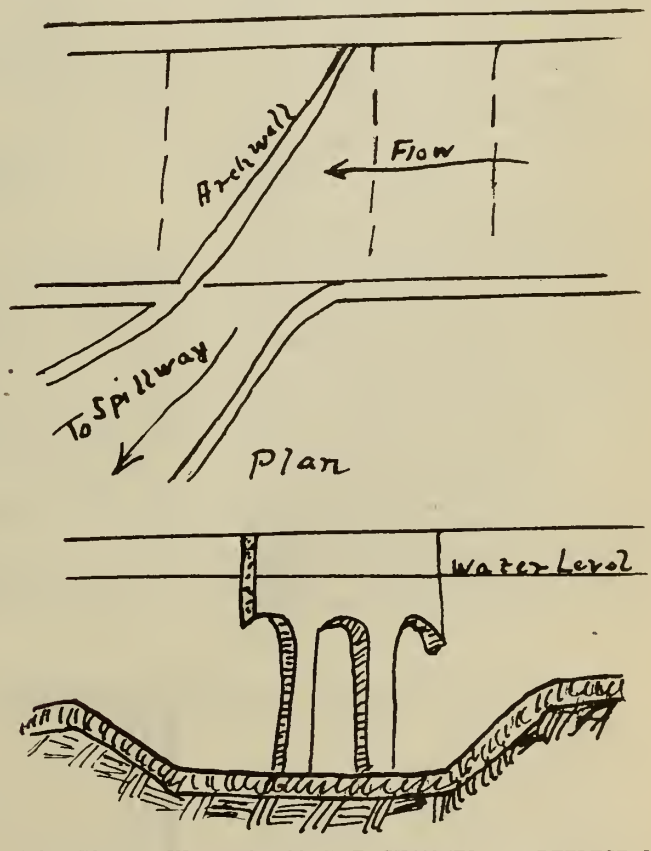
There are two methods of handling the ice problem, just as there are two ways of treating a headache. If you have a headache, are you going to take a powder and relieve the headache or are you going to get at the cause of it? The first can be called palliative, the second, preventive. The second method, that of prevention, is the only logical treatment in the case of either headache or ice troubles. To get rid of the ice up at the forebay and prevent its passing through the plant is the one best bet.

As to prevention, there are the following, which have shown their worth by actual operation:

(a) A log boom placed across the channel at about 45 deg., the discharge end of which deflects or guides the floating ice into a suitable receiving basin, whence it can be discharged over a spillway or sawed up for storage. If the spillway mentioned is properly design-



LOG BOOM STRETCHED ACROSS THE FOREBAY TO BY-PASS ICE.



ARCH WALL BUILT ACROSS THE CHANNEL TO DEFLECT ICE ACCUMULATIONS.

ed, the pressure of accumulation will force the ice over the spillway apron without manual aid, save perhaps in the case of very large pieces.

(b) A submerged arch, or series of arches, inclined to the channel width at not less than 30 deg., the crowns of the arches being submerged from 30 to 42 inches, according to climate. As in the case of the log boom, the ice is to be deflected or guided into a receiving basin and from there discharged over a spillway.

(c) Where Taintor gates are used in cases of waste spillways, or in cases where such gates are used as the means of draining the turbine pits, conditions will arise that will cause the gates to be solidly frozen in. In such cases the plant cannot be started; so it is a good practice to box in the top and sides of the gate nearest the power house, and to put in a generous sized steam coil inside of the gate. This will melt the ice around that one gate, and as soon as the flow is started, the other gates will thaw out successively.

(d) In very cold climates, ice will form around the speed rings of the turbine, and clogging up of the water passages will soon follow. This has been prevented by putting two coils of pipe around the crown plate of the turbine and connecting the two by means of vertical drop legs placed just outside of the guide vanes in the speed ring.

(e) I understand that some effort has been made to use travelling screens to keep the turbine pits free of ice, but unfortunately data on their cold weather performance are not available.

The log boom is made up of good sized tree trunks, of length to suit the location and connected by means of pieces of heavy chains, usually about 3 feet long, firmly spiked to the log ends. Figure 1 shows the log boom across the channel. The ice as it comes downstream is deflected into the receiving basin and the pressure of accumulation will force the blocks over the ramp of the spillway. From the spillway, the disposal will depend on the topography of the site. Where the entire river discharge passes through the plant, the ice spillway can be made as shown in Fig. 1, the spillway discharge going into a tumbling bay connected with the tailrace, the effect being that the ice merely by-passes the plant. The spillway, somewhat better shown in section M, should have a concrete slap ramp extending up to the normal winter water stage, and above the slab slots should be cut in the side walls so that the water can be saved by putting in stop logs in case the water should be abnormally high. To make the receiving basin self-clearing and avoid ice jams therein the side walls should diverge about 1 foot in each 10 feet, so that the channel increases 1 foot in width in each 5 feet of run.

In some cases in the colder climates, a log boom alone will not be sufficient. The logs, at the most, will probably sink only 12 to 18 inches below the water surface and quite a few good sized ice chunks will be carried under the logs by the current. Here the submerged arch will give good results alone, although I recommend that it be used in connection with the log boom. Refer to Figure 2. Such an arch wall should be set at not less than 30 deg. with the width of the channel and like the log boom it should guide the ice over a spillway or into a receiving basin. Since the immersed section of the arches, together with the piers, take up a considerable portion of the cross-sectional area of the channel, the channel should be made correspondingly deeper at that point.

As to the steam-heated Taintor gate, it is merely the conventional form boxed in on top and the sides. The bottom must be left open so that the water can freely come in touch with the heated air of the interior. The steam inlet should come in at a high point and be connected with the coil by flexible steam hose long enough to permit opening the gate fully. The coil should be drained by gravity and the returns trapped or gravitated to the boiler. As to the size of the coil, it must be said that it is wise to err on the side of generosity. Strictly speaking, the coil is used for starting the flow only, and the larger the coil the sooner the gate will be thawed out.

The same reasoning applies to the coils around the turbine speed ring, except that occasions may arise when it is necessary to use these continuously.

STRAIGHTENING ROTOR SHAFT

Recently I was given a job straightening a 2 in. rotor shaft, which was bent right at shoulder on pulley end, and as I thought it would be next to impossible to straighten it without taking shaft out of rotor, and as it is quite a job to take same out and place it again, I did it in novel way, which may interest some of our engineers.

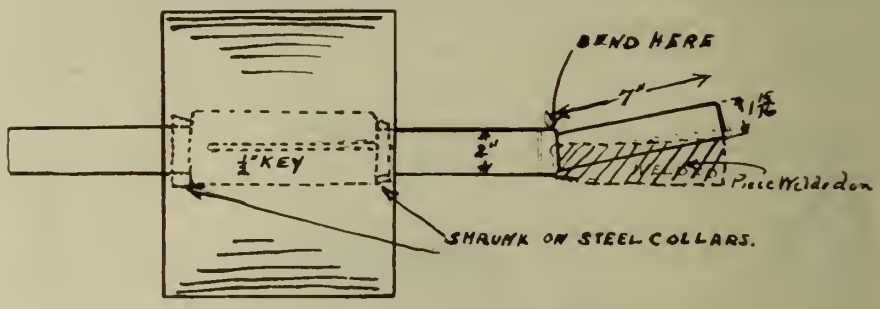
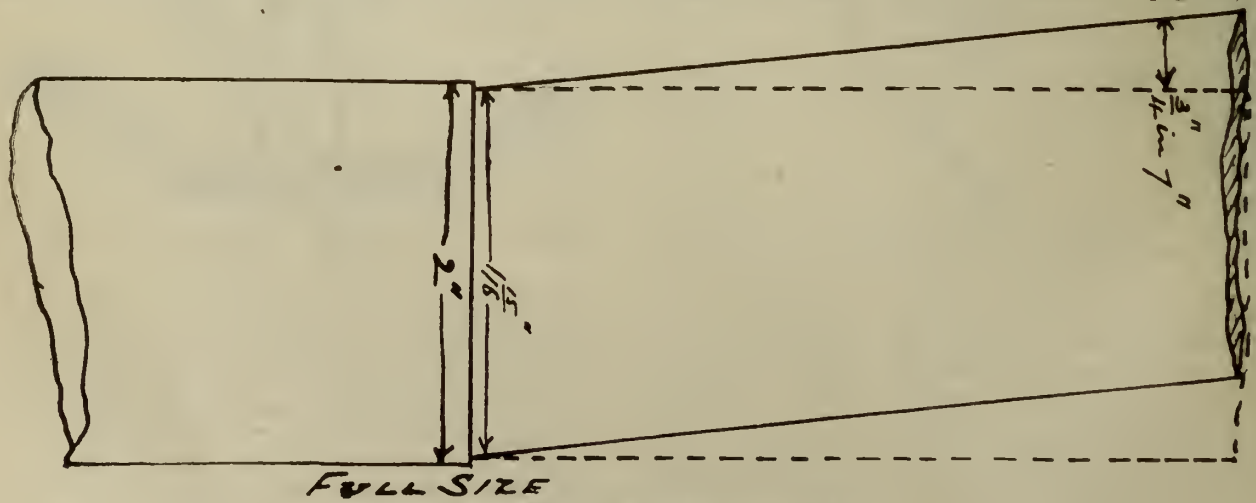


DIAGRAM OF ROTOR AND SHAFT.

The rotor shaft in question was bent in transit by the railway company and was out about ¾ in. As our readers well know only .008 inch is allowed between stator and rotor laminations, so it is seen that rotor shaft must be perfectly straight.

I did not care to heat it nor hammer it, so we had one side built up with elec-

(Continued on page 36)



FULL SIZE SKETCH SHOWING AMOUNT OF BEND.

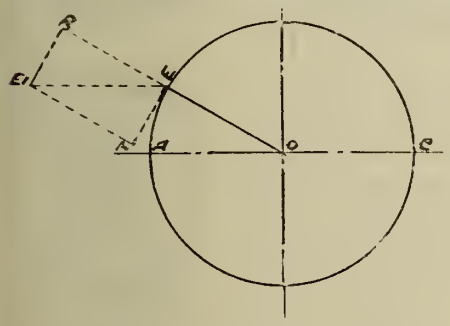
OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

TURNING MOMENT ON CRANK

Question.—What is the turning effort on a crank when crank is at centre of stroke?

Answer.—The turning effort for different positions may be found from a diagram. Thus, suppose the pressure is uniform and the connecting rod is of infinite length, construct the following diagram: Let the radius of circle OA represent to scale the load on the piston.



TURNING EFFORT BY PARALLELOGRAM.

When the crank is at OA or OC there is no turning effort, while from OA to OB the turning effort increases from O to a maximum. Suppose the crank at OE, then the force on the crank pin can be resolved into two forces, one acting to the centre of the shaft and one at right angles to it. Then the line TE measures to scale the tangential force acting on the pin, or the turning effort on the pin. This multiplied by the length of crank gives twisting effort on the shaft.

When the crank is at right angles suppose the rod to be of infinite length, then the load would be equal to the load on the piston. As the connecting rod is not of infinite length, but makes a definite angle, the load on the crank pin will be equal to the total load multiplied by the cosine of the angle the rod makes with the centre line of engine.

This can be shown diagrammatically: In the following diagram let P = load on piston, R = thrust on connecting rod, OC = crank, OD centre line at right angles to centre of engine, and OV a line perpendicular to R through centre line of shaft. Then the thrust on the rod R is equal to PCosA, and the twisting movement on the crank shaft is equal to Rx OV. The pressure will, of course, have to be determined for the various positions of crank from the indicator diagram, but when cut off takes place at half stroke the maximum pressure on the pin and the maximum turning movement on the shaft will occur at half stroke. We have neglected the effect of friction and of the acceleration and inertia of the moving parts.

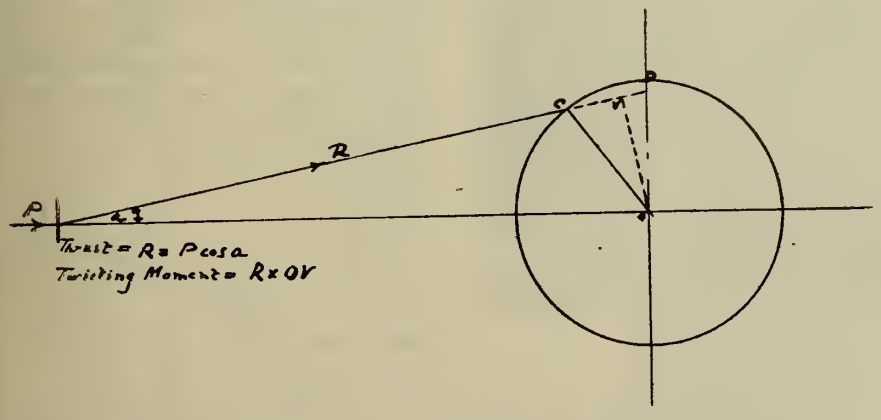
THE V NOTCH

Question.—How can I measure the flow of water over a V notch?

Answer.—If the flow is steady $q = \frac{4}{15} k w h \sqrt{29h}$ cubic feet per sec., where

w = width of notch in feet.

h = head of water from apex of V in feet.



THRUST ON ROD IS EQUAL TO PcosA. TWISTING EFFORT ON SHAFT = RxOV.

29 = 64.4 (gravity).

k = constant from .59 to .62, according to the angle of V, .59 being for a right angle.

When the angle is a right angle, then $q = 3h^2\sqrt{h}$ cubic feet per minute, h being in inches.

ANOTHER GRADED CERTIFICATE QUERY

To the Editor, Power House.

Can a superintendent of a factory who holds a second-class certificate take charge of the boiler room, leaving a man who has no certificate to work it? To the writer's knowledge the superintendent has but little time through the day to see how things are going on (in this case). This is a high pressure boiler. There is another factory here where the superintendent has a certificate and the hand man around, who has no certificate, but does the firing if this is allowed and there is no law for it. What is the use of the present system of graded certificates?—Woodstock, Ont.

OTTAWA LODGE, C.A.S.E.

Ottawa Lodge, No. 6, C.A.S.E., held its second open meeting on Thursday evening, Dec. 23rd, which had a large attendance.

Bro. C. V. Clarke, chairman of the Educational Committee, gave a very interesting paper on boiler-room efficiency, dealing with different systems of firing to give best results. He also dealt with the proper way of handling returns to avoid loss, which always amount to dollars lost when not properly handled.

Bro. G. I. Scott, chief engineer of the Ottawa Electric Co., also gave an interesting address in well chosen words on the proper handling and use of the rurometric condenser, explaining how troubles occur and how to overcome them. We congratulate Bro. Scott on securing his first-class certificate. I think he is first in Ottawa to receive a first.

R. E. RODNEY, Rec. Sec.

We have received a copy of the revised edition of "How to Build Up Furnace Efficiency," written by Jos. W. Hays, the well-known combustion engineer. This is the sixteenth edition of this well-known little book. It contains all the original matter and some new cartoons have been added. There is also an appendix on oil, wood, gas and other fuels. This book puts the subject of combustion in a most intelligible and readable manner, with the touch of humor that appeals to most of us, especially when introduced to lighten such a practical subject. It is chock full of sound advice and well worth the price, $1.50. It is published by Jos. W. Hays, Michigan City, Indiana.

Progress in New Equipment

THE GODFREY CONVEYOR

THE coal conveyor illustrated and described here is made by the Godfrey Conveyor Company, Elkhart, Indiana, U.S.A., represented in Toronto, by M. A. Kennedy, of 110 Richmond street W.

The principle of the Godfrey system is to get coal from bottom dump cars into a chute underneath the railroad track, the chute conveying it by gravity into a bucket in which it is elevated and carried to a storage pile or an elevated bin or conveyance.

The mechanical units consist of a bucket of approximately one ton capacity, a two-drum reversible hoist operated by electric motor or other suitable power, a trolley operating on a monorail or cableway, a steel chute with gates to control the flow of the coal, and the necessary sheaves, cables, etc., for making the connection of the various units.

The two types of overhead track, namely, the I-beam and cable-way, make the equipment easily adaptable to any one of a large variety of conditions. The principle and operation of both types is the same, while the choice depends entirely upon the local conditions which have to be met.

The entire operation is controlled by one man stationed at the hoist, which is located near the mouth of the track chute. This enables the operator to open and close the gate of the chute which controls the flow of coal into the bucket.

A hoist of special type is employed. This hoist is mounted on a cast iron base and is of ample proportion to carry the load. The operation of the two drums on the hoist is controlled by clutches, insuring speed and safety with ease of operation. The main or hoisting drum is used to elevate the bucket to the required height and the traction drum moves the trolley in either direction on the conveyor track. The trolley supports the hoisting cable on which the bucket sheave rolls; this enabling the man at the hoist to lower the bucket at any desired point under the conveyor track without making any changes or adjustments on the equipment.

A TYPICAL INSTALLATION

The coal when emptied out of the car falls by gravity through a specially constructed steel chute into one ton conveying bucket suspended or guide rails in a pit at the side of the track. When the bucket is filled the hoist operator closes the gate of the chute, thereby shutting off the flow of coal into the bucket. The hoisting drum is then engaged, which raises the bucket to the required height. The operation of the traction drum of the hoist then moves the bucket along the conveyor track to the point where the operator wishes to dump the coal.

The bucket is then lowered until it comes in contact with the coal pile. The contact releases a latch on the bottom of the bucket, opening the two doors and the coal flows gently out without any breakage and consequently no degradation. This means of tripping the bucket when in contact with the pile is a patented feature of Godfrey equipment. The bucket can be lowered or hoisted at any point, no stops or trippers being required. The largest lump as well as the finest screenings can be handled.

The coal is emptied as the bucket is raised and the bottom closes automatically. The bucket then travels on the monorail back to the pit for another load.

Coal can be stored to any height desired, bins or storage space filled to capacity with no trimmings, or wagons can be loaded directly from the cars with no breakage; all this by the labor of one man.

Ashes, sand, crushed rock, gravel and similar materials can be handled in the same way and as cheaply. In many cases the same equipment is used to unload, store and convey coal to the boiler room and remove ashes to cars or hoppers.

Coal can be reclaimed from open storage; or flat bottom cars unloaded by changing the conveying bucket for a "hook-on" clam shell bucket. Lumber, logs, or baled material can be handled by substituting grab hooks for the bucket. The possibilities for handling all kinds of manufactured articles or raw materials are practically unlimited.

The installation is very simple, due to the fact that the mechanical units are shipped assembled. The erection work consists of placing concrete for the track hopper and pit, also concrete bases for the A-frame which supports the monorail track and the hoist base. Where

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2

a cableway is used the supporting masts are set on concrete bases. The A-frame supports for the monorail may be constructed of wood. However, a special steel structure may be obtained and is recommended for permanency.

The hoist and operator do not travel on the monorail with the load, enabling a lighter construction to be used.

The operation is not confined to a straight line but can be made to include curves. It can be installed parallel to the railroad siding or at any angle thereto. The height of the track can be made to suit local conditions and storage requirements.

The above photograph well illustrates the Godfrey system. This installation represents the latest type of steel construction and is built at right angles to the siding.

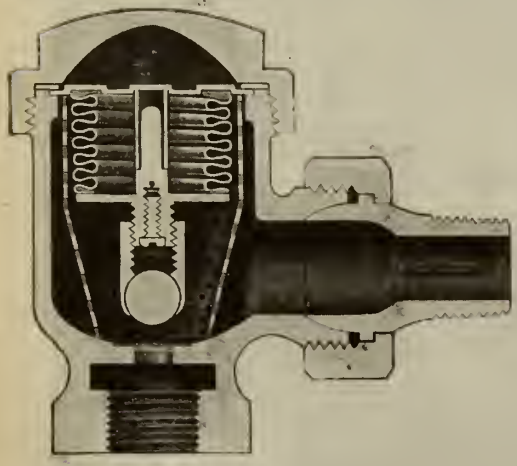
Coal is conveyed directly from cars to storage or chutes for stoking kilns. By interchanging buckets and substituting a reclaiming bucket, coal is picked up from open storage piles and conveyed to the chutes or direct to boiler room.

This particular installation serves kilns at some distance from the siding, cheaply and efficiently, and will store a large quantity for winter use.

The operation of the hoist does not require a skilled mechanic.

A NEW RADIATOR TRAP

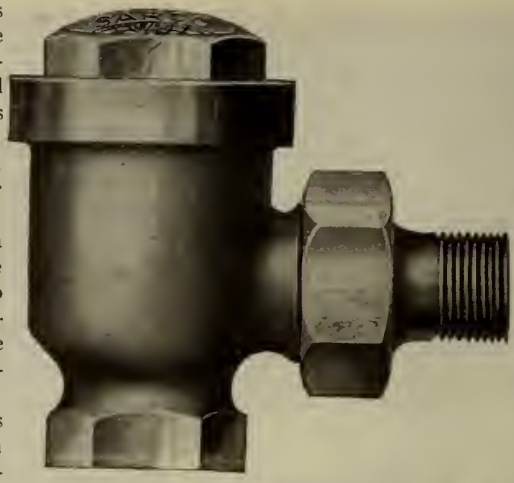
The Sarco Company, Inc., New York, has just placed on the market a new valve for radiators and steam heating



SECTION OF TRAP

service. This is a modification of the steam trap Sarco and approaches in design the standard types of radiator trap valves, while retaining the characteristic Sarco features.

The body is a heavy brass casting and the expansion element a Sarco spiral bellows. The valve head is a ball freely turning in a socket and a strainer of ample capacity is provided in the valve casing. This trap is factory adjusted. It can be used for any vacuum or for low pressure up to 20 pounds. It is claimed that the large discharge areas and the



OUTSIDE VIEW

movement of ¼ inch insure a larger capacity than any other type of thermostatic radiator valve can give.

STRAIGHTENING ROTOR SHAFT

Continued from page 2

tric arc welding process, then rotor was set up in lathe, welded end in steady-rest, faced and new centre put in, and then shaft turned to 1-64 oversize and then ground to exact size; it was then impossible to tell any defect nor that shaft had ever been welded. Operation took six hours and rotor never got hot enough to melt solder out of rotor rings.

ERNEST QUIST.

The idea shown above is quite satisfactory as regards truing the shaft. It does nothing, however, to relieve the strain set up on the fibres of the shaft at the shoulder, where it was bent. We think that the rotor could have been protected by a shield from radiant heat and the shaft warmed at the bend by a blow torch and straightened up by pressure. It could then have been heated to a dull red for two or three inches each side of the bend, and allowed to cool, after which it could have been trued up in the lathe. The insulation would not have been damaged in this way, and the molecules of the metal would have been returned to their normal condition. As it is a certain amount of initial stress is present when no load is on the shaft, and this the welding would not help. We would like to hear some opinions from our readers on this.—Editor.

M. A. Kennedy, Ltd., of 110 Richmond Street W., Toronto, have accepted the agency for Ontario of the Godfrey Conveyor Company, Elkhart, Indiana, U.S.A. This firm specialises in the manufacture of a coal handling conveyor, consisting of a hoisting and tractor drum, and a series of supports carrying either cable ways or I beams. The coal is transported in one ton buckets, which are so designed that they are tripped when the bucket comes in contact with the coal pile. This eliminates or reduces to the smallest possible degree the breaking of the coal by dropping a long distance from the bucket to the pile. It is claimed that the whole apparatus can be handled by one man, and used for loading, unloading, and reclaiming coal from storage. There are a large number of these equipments in use, and giving satisfactory service.

CATALOGUE

The Mason Regulator and Engineering Co. have issued a very handy catalogue in a form that can be hung up like a calendar and shows at a glance the name of all the lines handled by them. The particular article or piece of apparatus, which is interesting the buyer at the moment, can be turned to immediately, without any loss of time. The lines include the well-known Mason regulating and reducing valves, Reilly heaters, feed water filters, evaporators, Ashton safety valves and steam gauges, and other well-known power plant specialties.

We have received Catalogue F of the Ross Heater & Manufacturing Co., Buffalo, N.Y., illustrating and describing their various types of heaters. There are two general types, the instantaneous heater and the storage heater. In the first the water is heated as it is being used, while in the latter a certain storage capacity is provided to be drawn on in emergencies. Full descriptions of the different designs manufactured in both types is given, with tables of capacities and diagrams of installation layouts. Condensers, expansion joints, and air-jectors manufactured by the Ross Heater Co. are also illustrated.

Ready to Operate.—The new industrial plant of Machinery and Foundries, Ltd., Brockville, Ont., is almost ready for operation. General foundry and machine products will be turned out and special attention will be paid to the manufacture of power and hand pumps. The cost of the construction of the plant will be about $75,000.

Creosoted wood cannot be painted over successfully, because the oil quickly comes through the paint and discolors it. Although pressure treatments are the most expensive they are the most effective because they result in the greatest absorption and penetration of preservative. Roof planking should receive 8 lb. to 12 lb. of creosote per cubic foot, or ½ lb. of the salt if zinc chloride be used. Such treatment should add at least twenty years to the life of roof plank. Lumber should be cut to final dimensions before treatment. Whenever it becomes necessary to cut into treated timber the untreated wood exposed by cutting should be given two brush coats of creosote or some other preservative.

WATER POWER AND LOCATION OF PLANT

The presence of coal has been one of the most important factors determining the industrial expansion of various countries during the past hundred years or so.

This condition is gradually changing through the exhaustion of coal supplies. A recent article by G. H. Ashley, State Geologist of Pennsylvania, emphasizing the necessity of replacing coal by water-power, is particularly significant, coming from one who is well able to judge the situation in this great coal state. His statements are of special interest to Canada in view of the prediction that industrial supremacy will, eventually, pass from coal-depleted regions to areas where large water-powers are available. It is even pointed out that one way of keeping the industries where they are in the United States would be by the importation from Canada of enormous quantities of hydro-electric energy available on the St. Lawrence and at Niagara.

Mr. Ashley holds that: "The industrial East has maintained its supremacy because of cheap fuel and nearness to markets. Because of cheap fuel Pittsburgh can afford to haul iron ore from Minnesota. It does not take a seer nor even a scientist to point out that, if our present increased use of power continues, a generation will see the exhaustion of cheap fuel in the East."

"A review of the field today shows that, in several of the districts, practically all of the thick coal has been mined out, while in others it is possible to count the years to the time when the supply will be gone. It may be argued that, as the cost of coal increases, the manufacturing interests of the East will turn to water power. That argument leads to the question of the adequacy of the water-power of that region to take over the burden now carried by coal."

"In addition to the powers within the boundaries of the northeastern United States, there are large powers to the north in Canada. The St. Lawrence below the international boundary is estimated to have a potential horse-power of nearly 1,500,000, and the provinces of Quebec and Ontario have been estimated to have a maximum of 6,000,000 h.p. each, including that from Niagara and the St. Lawrence. Already 125,000 h.p. is imported into New York from Ontario, and a small amount is imported into New England. If all of the Canadian water powers were developed and Canada would allow the exportation of, say, one-half the power, or 6,000,000 h.p., it is probable that the northeastern corner of the United States could look forward to an ultimate utilization of not less than 10,000,000 to 12,000,000 water horsepower."

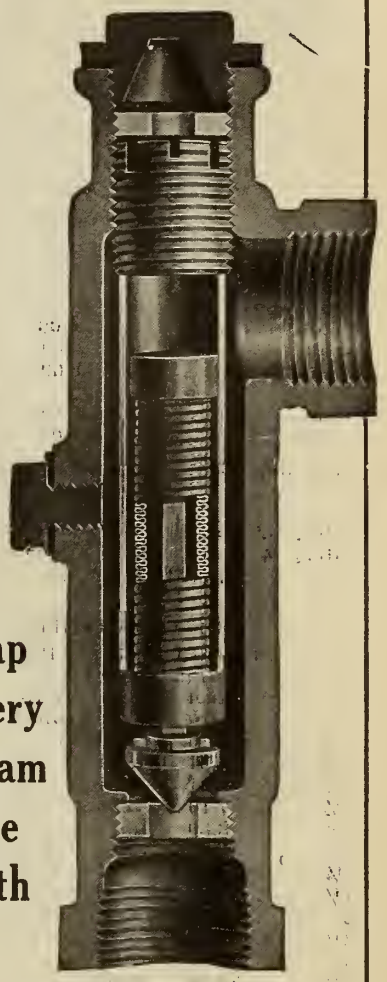
It need hardly be pointed out that the benefits accruing to Canada from the exportation of 6,000,000 horsepower would be relatively negligible. One large manufacturing plant using, say, 1,200 h.p., would employ more men than the water-power plants generating 6,000,000 h.p.

THE USE OF PEAT AS FUEL

In a lecture delivered by Professor P. F. Purcell before the Royal Dublin Society and published by the Fuel Research Board, it is stated that the total amount of peat used in Ireland lies between six and eight million tons per annum, as compared with 4¾ million tons of coal imported and 90,000 tons raised in the country. Irish peat has advantages in two respects, (1) the ash content is comparatively low, and (2) the nitrogen content is comparatively high. It is, therefore, a good peat for the recovery of sulphate of ammonia. Peat, generally speaking, contains from 90 to 95 per cent. of water, and part of this moisture cannot be pressed out owing to it being held by the colloidal matter in the peat. There are at present only two installations in Ireland where this fuel has been successfully employed for the generation of power. One is at Clifton, in Galway, where the Marconi Company uses 5,000 to 6,000 tons of air-dried peat to generate the power for the wireless station. The other is at Portadown, where the power for a linen factory is obtained from a producer gas plant using peat as the fuel.

In a paper dealing with the uses of aluminium for electric installations, Mr. E. O. Pannell, the author, states that aluminium can be drawn three times as far as copper without having to anneal it. The finished wire should indicate 58 to 62 per cent. of the conductance of copper wire of the same size, but it is usual to take 60 per cent. for this figure and a tensile strength of 24,000 pounds per square inch. Thus, if it is required to replace a copper wire on an overhead line with one of aluminium, the latter must have a 29 per cent. greater diameter and a 66 per cent. greater area. To increase the tensile strength and so permit a reduction in the sag of the conductor between the supports aluminium strands are laid around a core of steel wires. The steel wires are double galvanized and impregnated with fish oil to prevent corrosion. A cable of this type is about 35 per cent. heavier than aluminium, and costs, it is stated, 4 to 5 per cent. more; but it has a sag on long spans of 50 per cent. less, so that especially high towers are obviated.

Auxiliary Power Plant.—The Oakvillle town council are again considering the possibility of adding an auxiliary power plant to the present one in the pumping station. During the sleet and ice storm some weeks ago, the power supplied by the Dominion Power & Transmission Lines went off.



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1½-in.	31 50	29 50
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2 -in.	35 00	30 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

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Plates, ¼-in. up	6 00	5 50

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Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	28.74
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

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4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 30%.
4½-in. and larger, 10%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 30c lb.; class C black, 20c lb.; galvanized, class B, 40c lb.; class C, 30c lb. F.O.B. Toronto.

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Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	29½
Palacine	32½
Machine oil, per gal.	65
Black oil, per gal.	34
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	19

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	Net
Carriage bolts, 7/16 and up	+10%
Coach and lag screws	—15
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	+10
Machine bolts, ⅜-in. and less	+10
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 50
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 28½
Solder, guaranteed	0 30½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	4 00
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$35 00	$37 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	40 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	43 00	46 00
Copper sheet, planished, 16-oz. base	47 00	50 00
Braziers', in sheets, 6 x 4 base	39 00	42 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	23	Atlas	19
Peerless	22	X Empire	18½
Grand	21½	Ideal	18
Superior	21½	X Press	17
X L C R	20		

Colored

Lion	16	Popular	13
Standard	14	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20	Dark colored.	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Toronto
Tin	$45 00	$50 00
Spelter	8 75	10 00
Lead	7 75	9 00
Antimony	8 25	9 00
Aluminum	35 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

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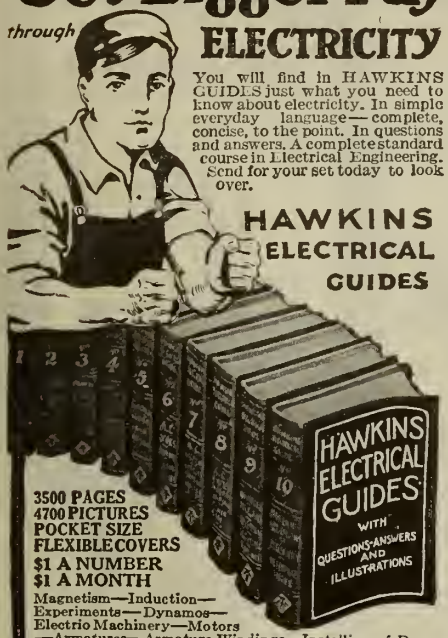

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All in First-Class Condition, as follows

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4—C. G. E. 5 H.P., 550 Volt, 25 Cycle, 1500 R.P.M., 3 Phase, with Compensator	195.00
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OF CANADA, LIMITED

FORD - ONTARIO

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LEATHER AND RUBBER BELTING, USED, but in good condition; at about half new price. Apply, mentioning "Power House," to Tarshis & Sons, 400 Front St. East, Toronto.

WE HAVE A QUANTITY OF NEW RUBBER belting to sell at less than half price; will ship C.O.D., subject to inspection; new circular saws, good second-hand leather and rubber belting, wire cable, vises, chain blocks, garden hose, steam hose, rubber packing; send us your requirements; our quotations will surprise. Apply, mentioning "Power House," to The York Belting Co., 115 York St., Toronto, Ont.

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ENCLOSED LIQUID FUEL COMBUSTION APparatus capable of generating intense heat in pipes and confined passages for heating parts of internal combustion engines and for other uses; spark ignited; blower operated. Patented October 8th, 1918. Can be inspected at and for sale by H. W. Petrie, Limited, 131 Front St. W., Toronto.

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WANTED—A1 GENERAL BLACKSMITH FAMiliar with mine and mill work; permanent position. Apply, mentioning "Power House," stating experience and wages wanted, to Moose Mountain, Ltd., Sellwood, Ont.

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THE JOHN INGLIS CO., LTD., ENGINEERS and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention "Power House."

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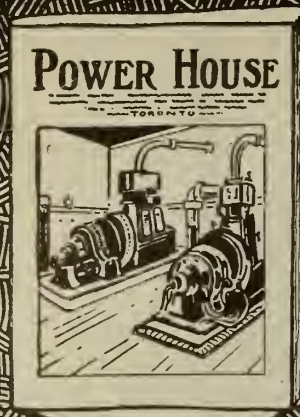

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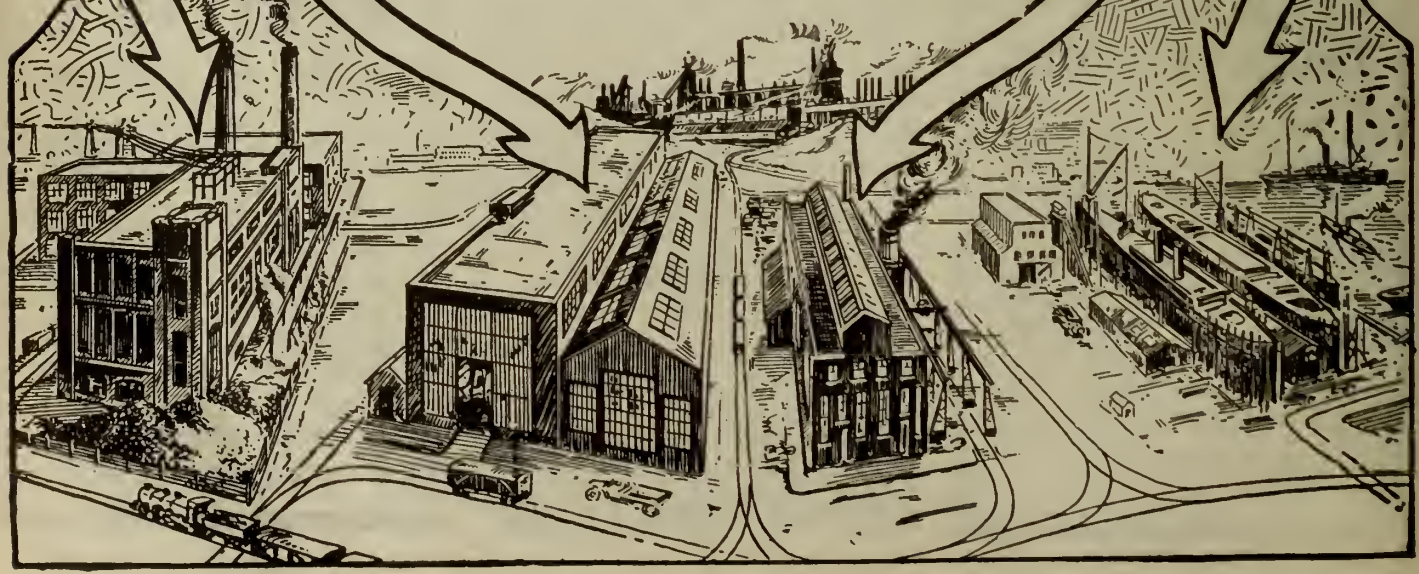

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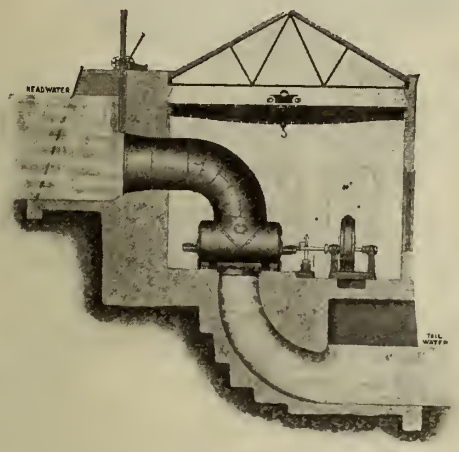

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BEFORE a Copes Boiler Feed Regulator is installed, a careful study is made of the plant and its operating conditions. While the construction of the Copes is extremely simple, the essential parts are capable of many fine variations. They have been developed to meet every conceivable condition in boiler feed water regulation. No matter how difficult your problem, how futile and apparently hopeless all previous attempts at automatic boiler feed regulation may have been, we can provide a Copes that will handle it without fail.

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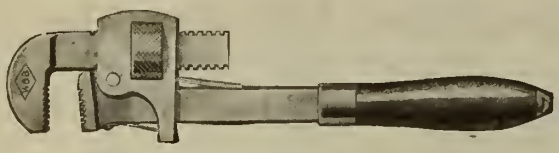

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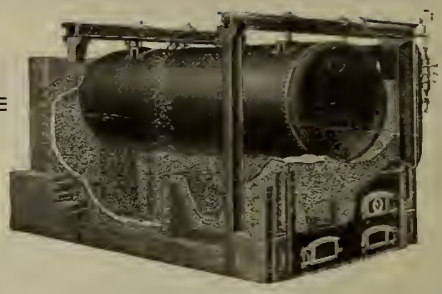

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Sureness means

THE ANDERSON
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The Anderson Separator should be in every boiler room.

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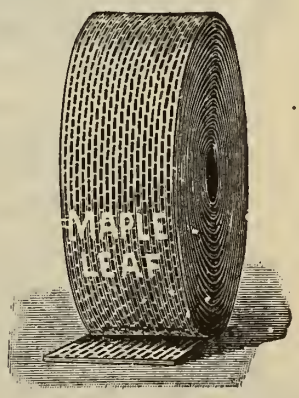

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

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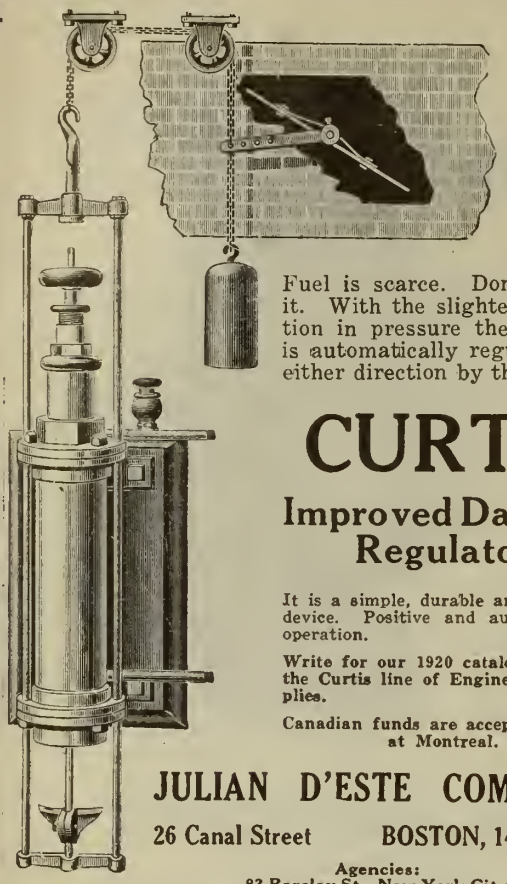

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It is a simple, durable and effective device. Positive and automatic in operation.

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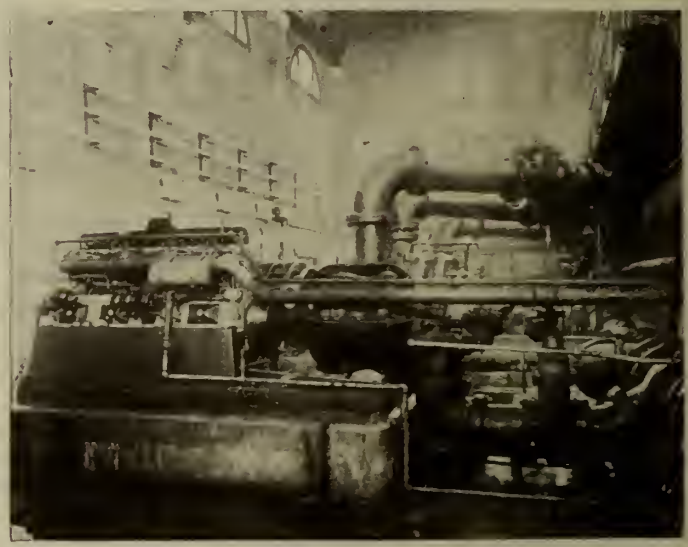
A dependable **Sterling** THE ENGINE of REFINEMENT *For the finest boats that float*

high duty 250 H.P. gasoline engine costs $19 per H.P.



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It does away entirely with the necessity of carrying a varied assortment of packings in stock, as from a single supply, in fact from the same can, you may pack anything, large or small.

For steam, water, oil, ammonia, air, low or high temperatures, superheated steam, turbines, etc.

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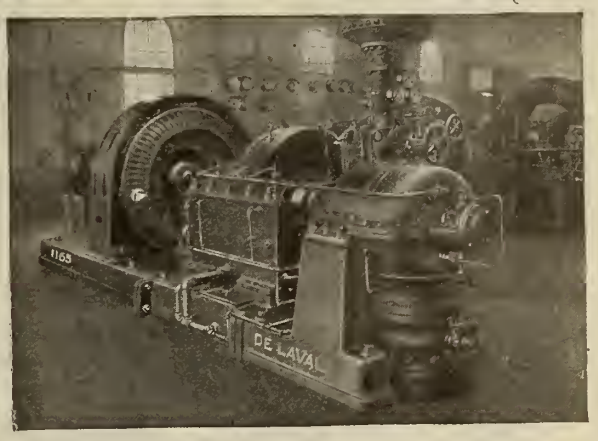
A TURBINE-DRIVEN A.C. or D.C. generator is more efficient, and is simple and easy to take care of.



350 K.W. Geared Turbine-driven Alternator.

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TAYLOR ENGINEERING CO., LTD., VANCOUVER

58

TRADE MARK

TRADE MARK

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

One of the best illustrations that we can give of the effect of frictional heat is shown in the test of Magnolia Metal in comparison with a dozen or more of the best known brands of Genuine Babbitt.

This test was made by Dr. Torrey (deceased), then chief Assayer of the United States Mint at New York.

The Magnolia test block was run for eighty minutes with variable loads up to 2,000 pounds per square inch, 1,600 R. P. M. on 5-inch shaft.

Not one of the Genuine Babbitts came within measurable distance of Magnolia, as they ran out in from five to fifteen minutes at loads of 500 to 1,000 pounds per square inch—one reaching 1,400 pounds, but failing in ten minutes. The failure of the Genuine Babbitts was not from lack of quality, but simply because the frictional heat could not be prevented from reaching a destructive temperature, although tested on the same machine and under the same conditions as Magnolia.

Some of these genuines might have been slightly harder than Magnolia, and Magnolia would have squashed in exactly the same way under the same low stress, had not its self-lubricating quality kept the temperature from rising beyond a safe limit.

At moderate speeds and pressures these Genuines might never have given such evidence of their deficiency and would have been credited with being as good, if not better, than Magnolia.

This Magnolia quality, as exemplified by this test, shows the saving grace of a low frictional co-efficient and also the futility of mere hardness to save a metal from squashing.

(Continued next month).

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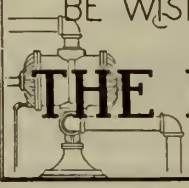

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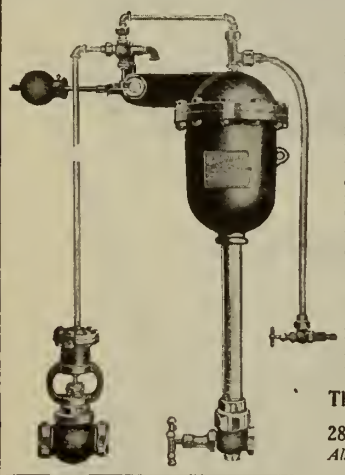

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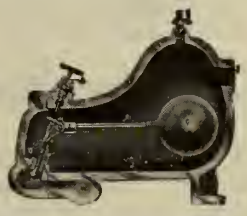

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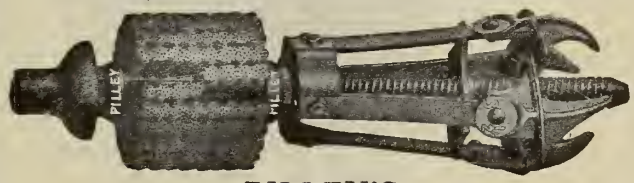

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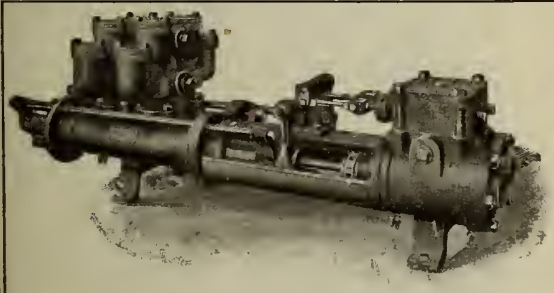

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Look on page 39

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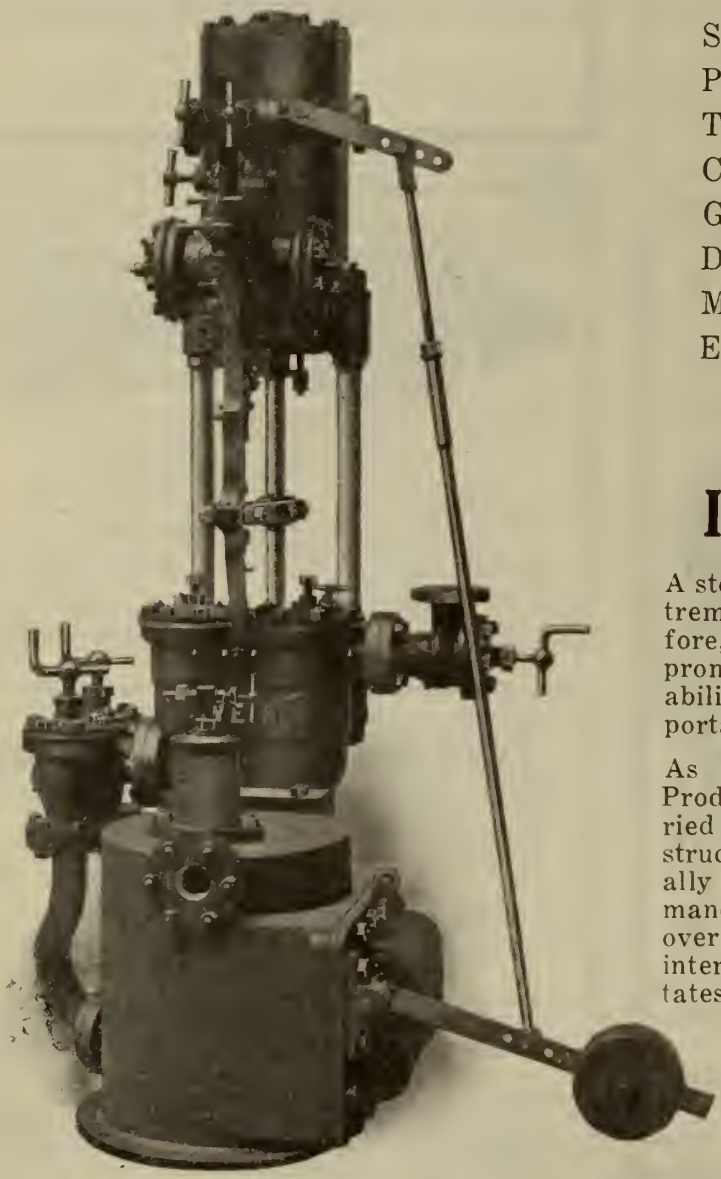

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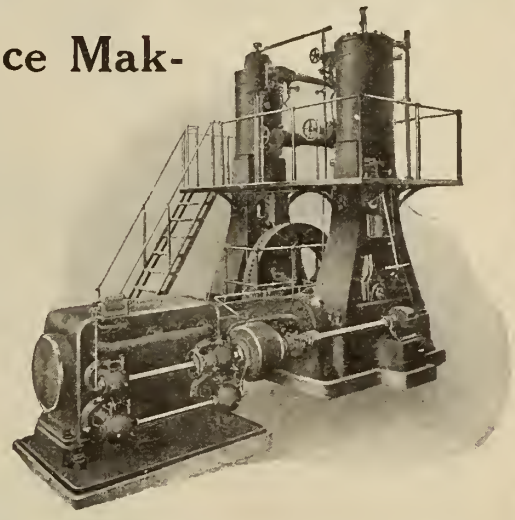

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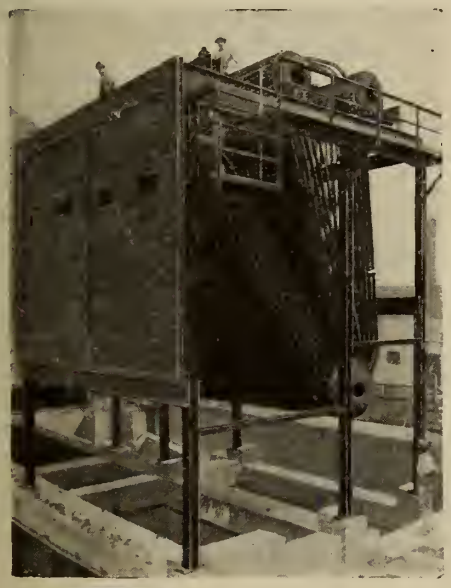

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Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOILER TUBE
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Limited, Toronto.
Green's Economiser, Ltd., Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Fluc Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green's Economiser, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Becher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabua Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS AND EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.
Godfrey Conveyor Co., Elkhart, Ind.
Jeffrey Manufacturing Co., Montreal.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke Que

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, ue.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford
Robb Engineering Works, Ltd. Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd. T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The Montreal.
Coppus Engr. & Equip. Co., Worcester Mass.
Sturtevant Co., B. F., Toronto, Can

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn
Robb Engineering Works, Ltd. Montreal
MacGovern & Co., Inc., Montreal, Que
Waterous Engine Works Co., Brantford
Northern Equipment Co., Toronto

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chanlin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd. Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
International Chemical Co., Toronto, Ont.

FIRE BRICK MORTAR
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal,

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal,

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLOW METERS
Bailey Meter Co.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equip. Co., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk. Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co'e., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW (Air, Gas, Steam, Water)
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.
The Mason Regulator & Eng. Co., Ltd. Montreal.
Yarnall-Waring Co., Philadelphia, Pa.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd. Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

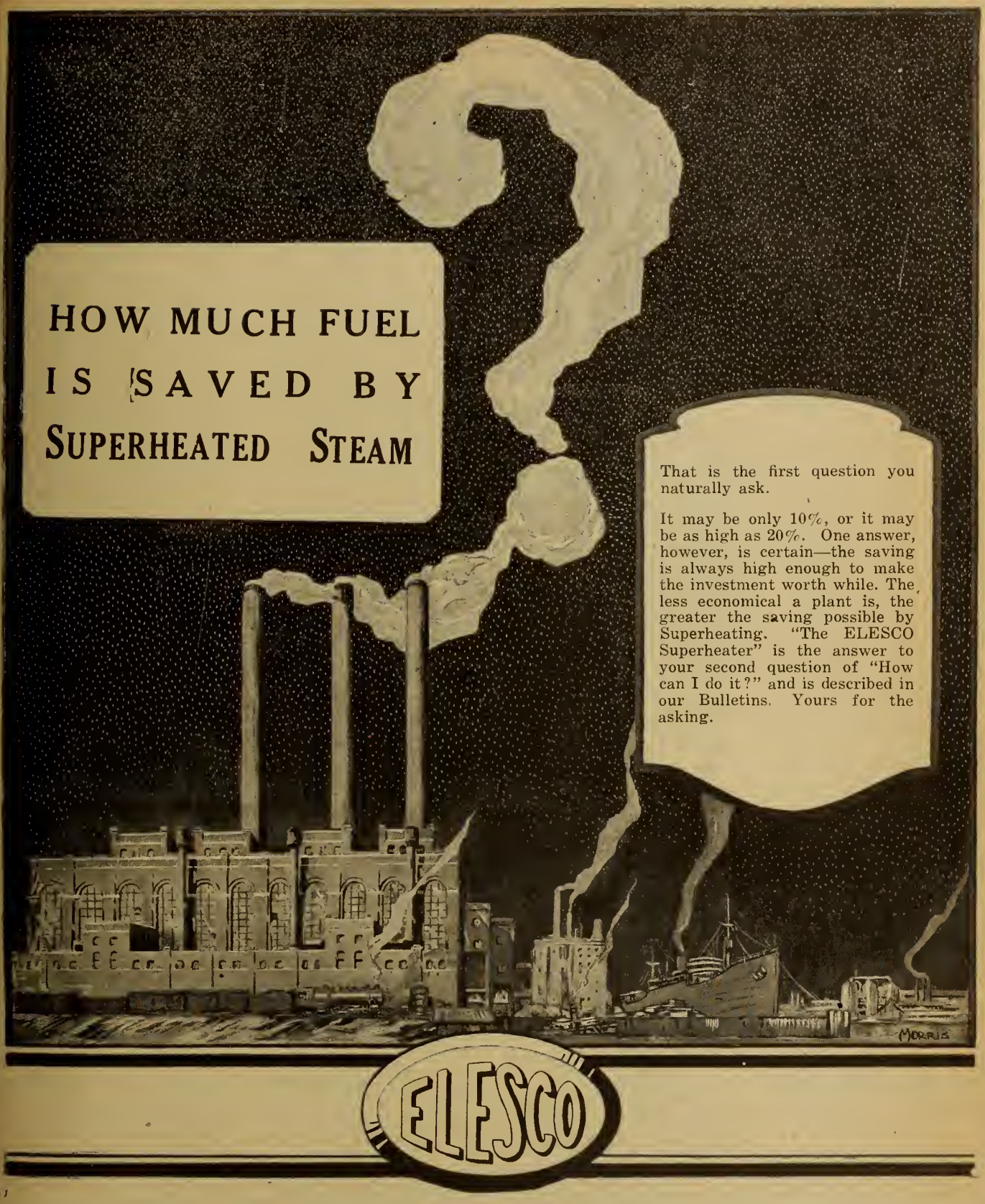
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn
Pratt & Cady, Hartford, Conn.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D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
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Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

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Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

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C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

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S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Hays Corp., Michigan City, Ind.

RECORDEDS CO2
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.
Uehling Instrument Co., New York, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay,
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

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Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

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Waterous Engine Works Co., Brantford.

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W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

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J. H. Williams & Co., Brooklyn, N.Y.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd. Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

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J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
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Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

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Mueller Mfg. Co., H., Sarnia, Ont.

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Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

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American Steam Gauge & Valve Mfg. Co. Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, St Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

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C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto

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Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

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H. Mueller Mfg. Co., Ltd., Sarnia.

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Penberthy Injector Co. Windsor, Ont.

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Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
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Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

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Dart Union Company, Ltd., Toronto, Ont.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia
Valve Engineering Company, Toronto.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

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VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

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REPUBLIC CO_2 RECORDERS and FLOW METERS Make a Good Combination —*Use Both*

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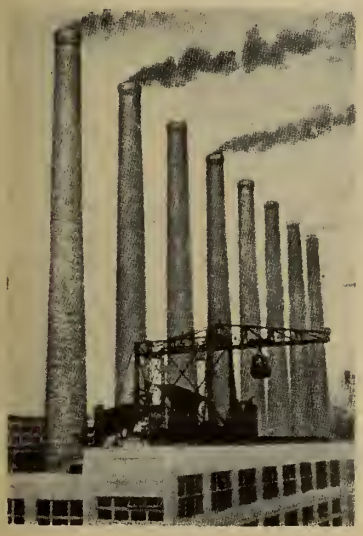

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A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building — LONDON, ENG.: 88 Fleet Street, E.C. — WINNIPEG: 1103 Union Trust Building

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Uehling CO_2 Continuous Recording Equipment

HE LIKES UEHLING EQUIPMENT because it gives him, right in his office, a continuous record of the combustion efficiency of each individual boiler. It provides each day a twenty-four hour history of the fuel economy maintained and how much fuel is unnecessarily wasted up the chimney. The chart tells the results of each fireman's efforts and the condition of every boiler setting. Such daily information is a necessity if maximum economy is to be maintained.

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Write for Catalog 111

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Combustion Engineers

2008 Empire Bldg. New York

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Three Months Continuously—Peak Loads at 340%
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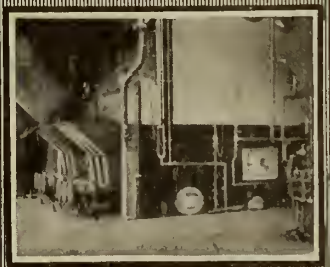

Three Months of High Capacity
Boilers kept on line continuously for over 3 months. Loads varied from 75% of boiler rating to 250%. Name on request.

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ALWAYS AVAILABLE

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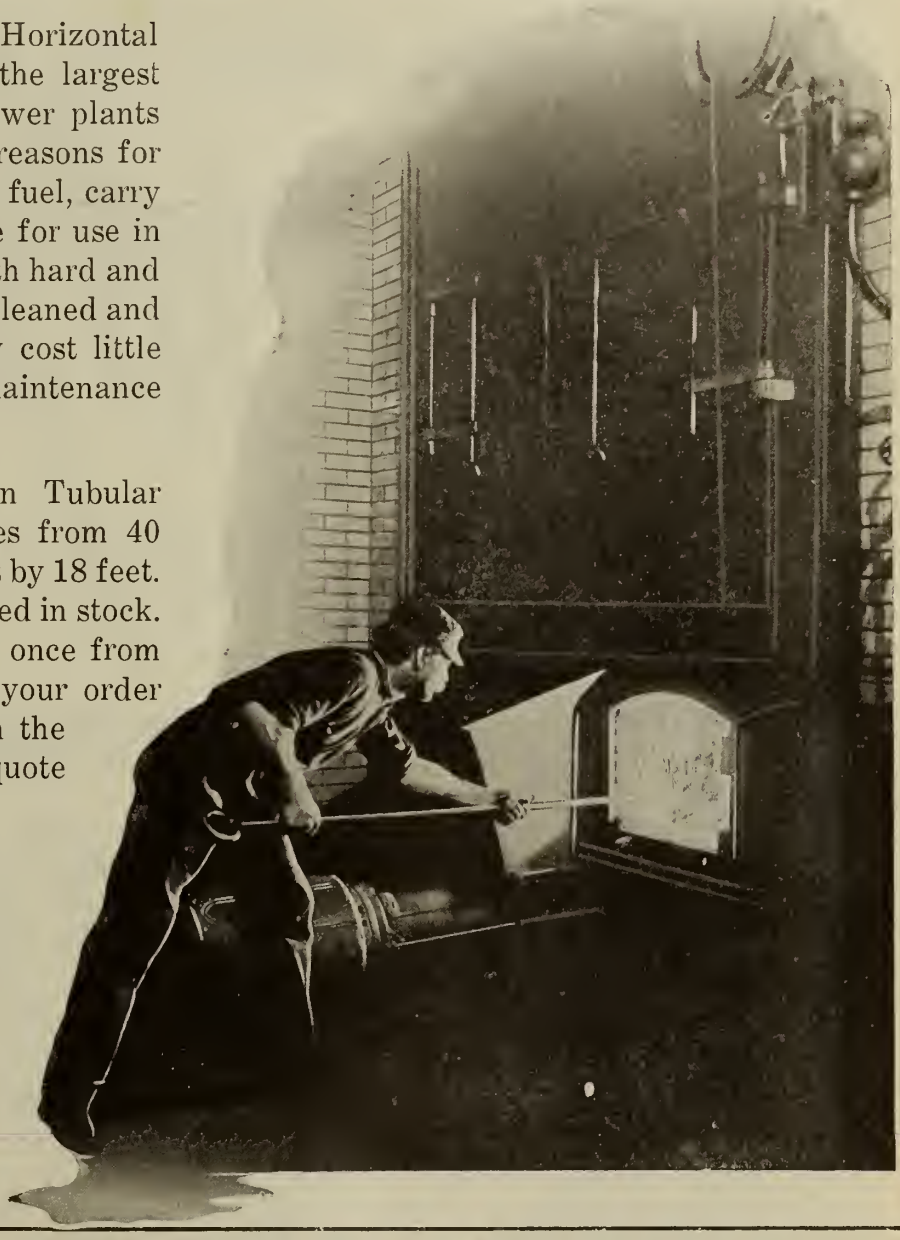

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5—40 H.P. "
6—60 H.P. "
2—No. 20 Kewanee Type Heating Boilers

Waterous

BRANTFORD, ONTARIO, CANADA

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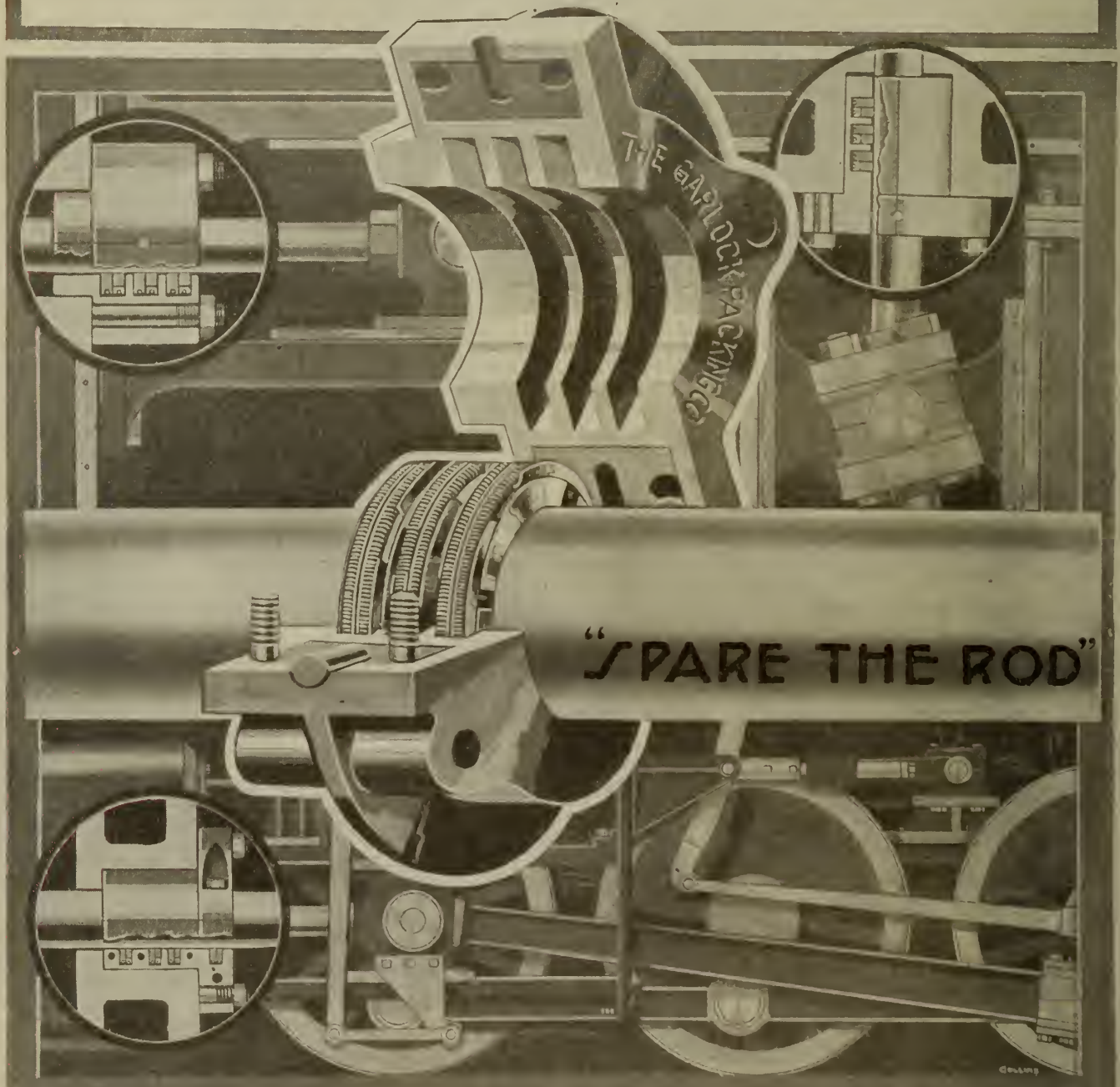

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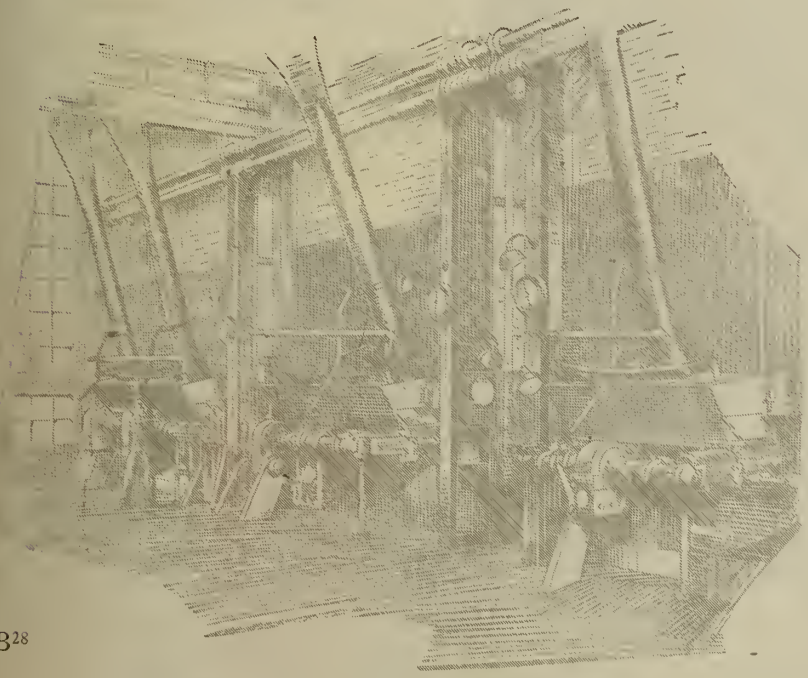

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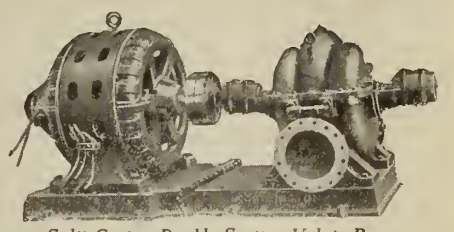

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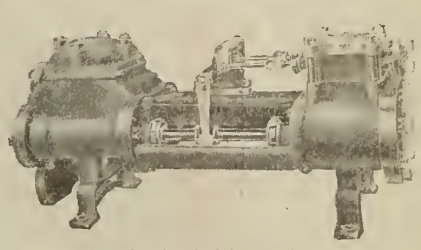

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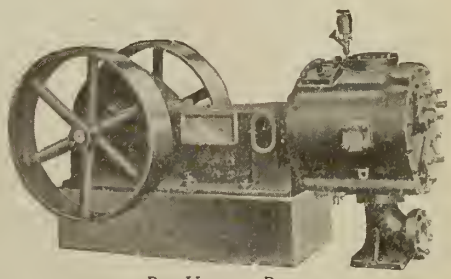

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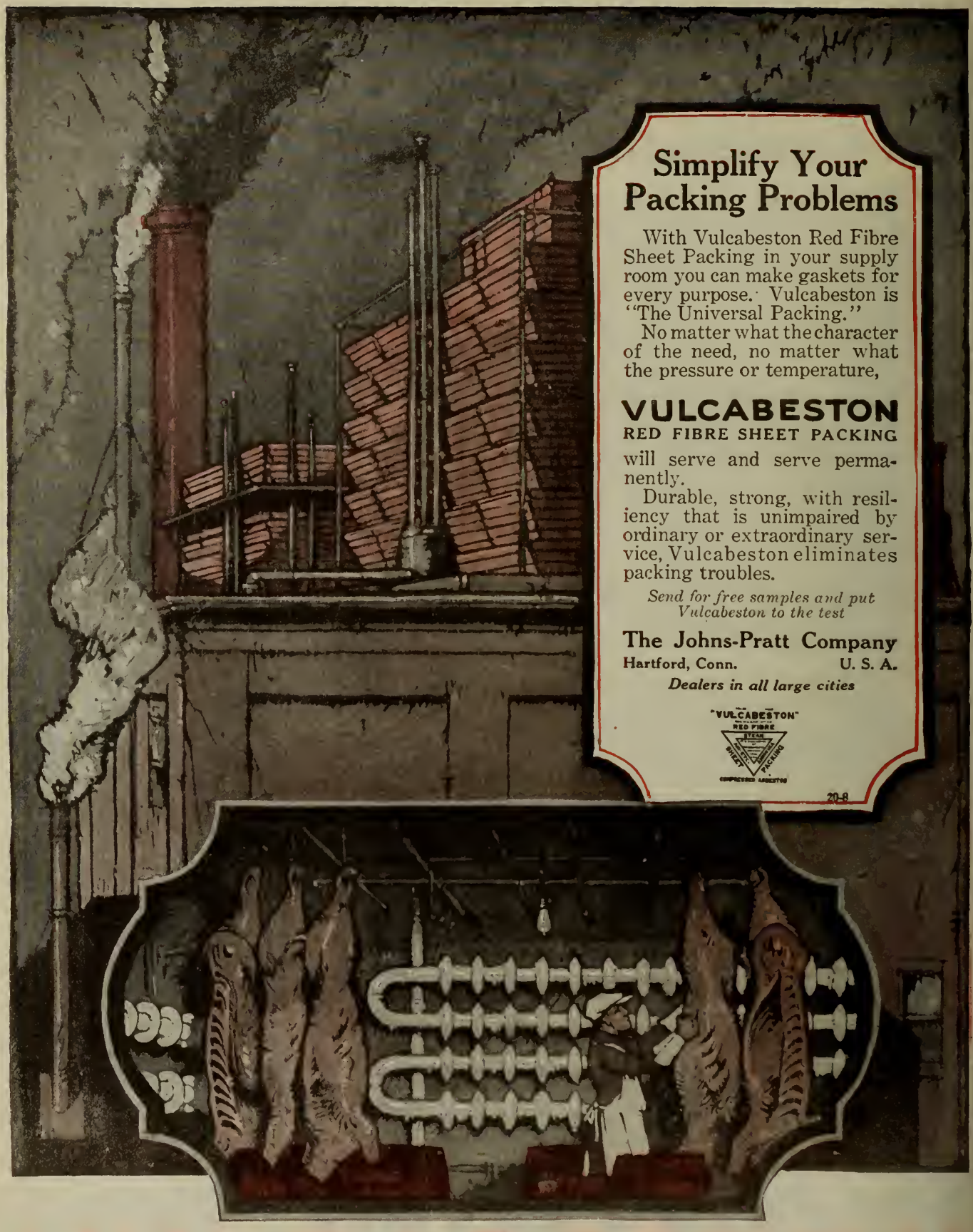

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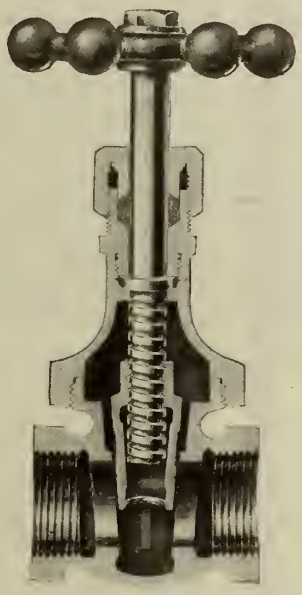

Fig. 567

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Improved Design Improved Efficiency

All Penberthy Gate Valves are designed with outside bonnet construction, same as our compodisk and regrinding lines of valves. It is the most practical and reliable idea of valve construction.

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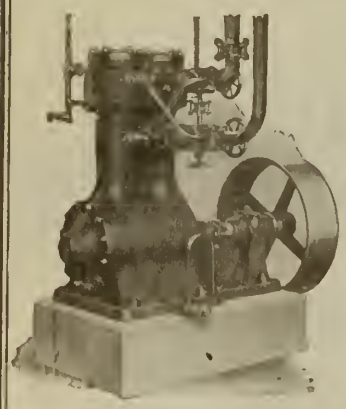

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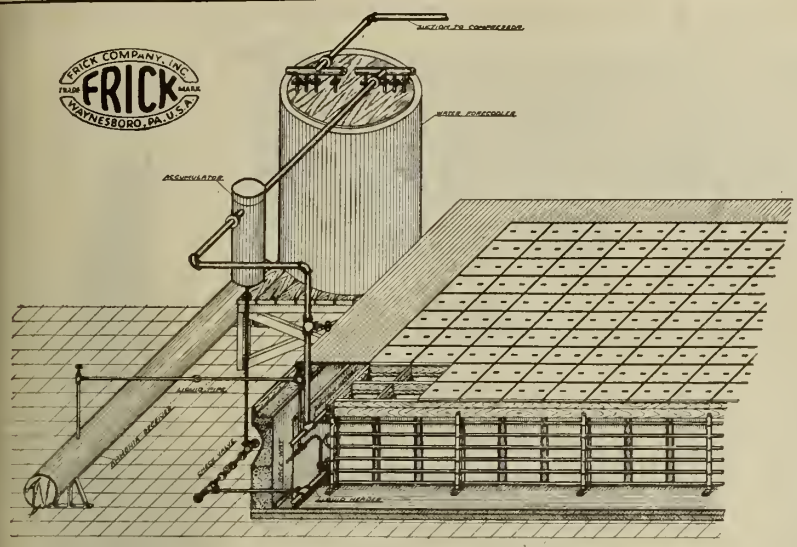

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One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

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Canadian Representative:

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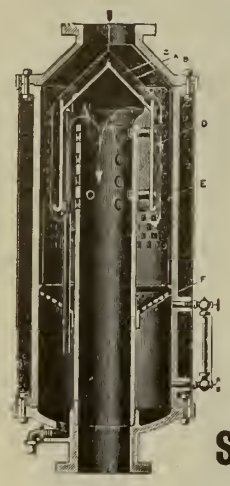
III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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One installation will convince YOU.

Booklet on Request

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ALSO ON PAGE 52 FOR REFRIGERATION ADVERTISEMENT

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

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"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

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Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

New Truths and Old Fallacies

Hardness of Alloys

The foregoing brings us to the discussion of the relative hardness of White Metal Alloys.

Many babbitt users lay great stress upon obtaining extra hard metals; usually specifying tin base metals with high copper content. We shall submit, further on, some comparative figures which do not bear out the usually accepted belief in that connection, and are as subversive in their ways as are the figures relating to the melting points of metals. These figures do not sustain the reputation of copper as a hardener, nor of the superior hardness of tin base metals.

They also disclose the fact that if a babbitt's value depends upon its hardness, the lowest grades of babbitt would sustain the load put upon a majority of bearings, which rarely exceed 500 pounds per square inch, and often much less.

Extreme hardness can only be obtained at the expense of malleability. The hardest babbitt is a lead base metal containing a high percentage of antimony, which is quite brittle, and, therefore, its use is confined largely to Rolling Mill and other similar bearings where the lining is thick and securely backed to prevent the metal cracking.

Magnolia is often loosely characterized as being a soft metal. This is doubtlessly due to its velvety feeling to the touch, a less metallic ring than Genuine and its being easier to break. Not even the Brinell test is a safe guide in determining the relative resistance of babbitts under a crushing strain. In fact, there is a surprisingly small difference in the sustaining powers throughout the entire list of babbitts in general use.

(Continued next month)

For copy of complete article:
"New Truths and Old Fallacies"
Address our Montreal Office

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MAGNOLIA METAL CO.
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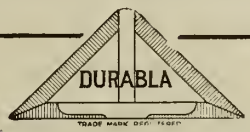

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Every Glass

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Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

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Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

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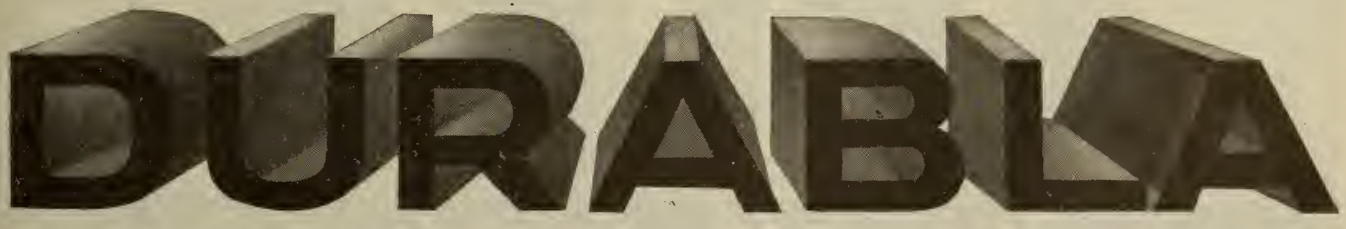

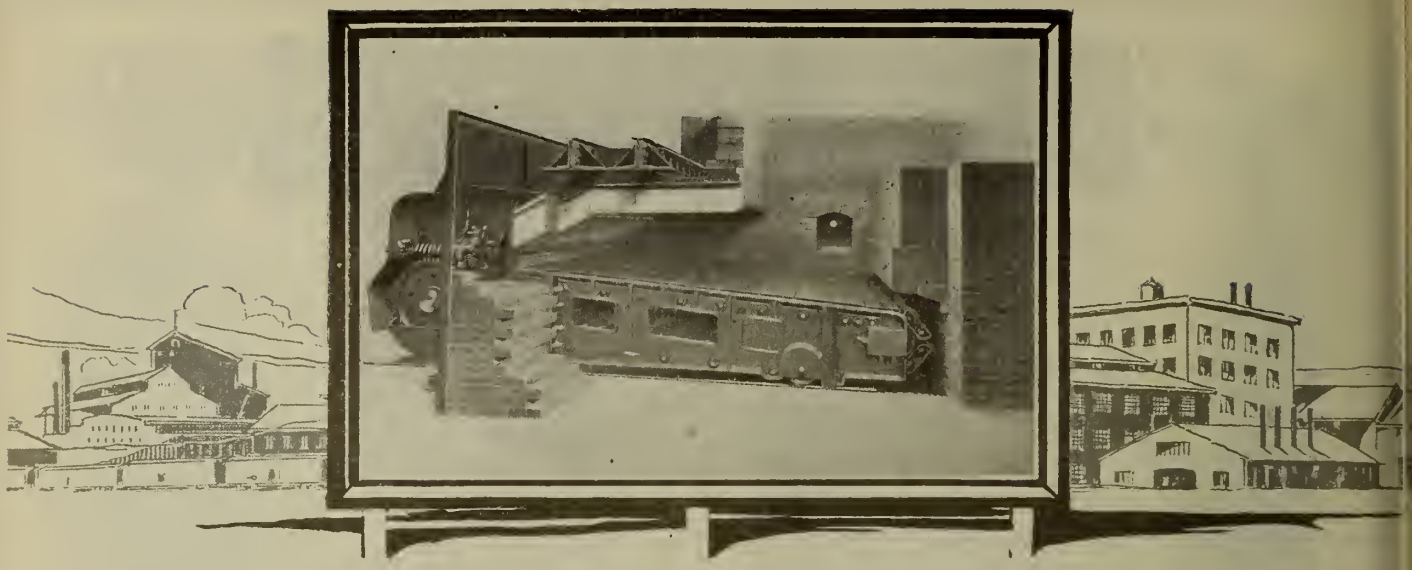

The L-C Chain Grate Stoker—the natural-draft type for higher volatile coals—dominant in this field today

Who is Buying

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Armour's QUALITY PRODUCTS

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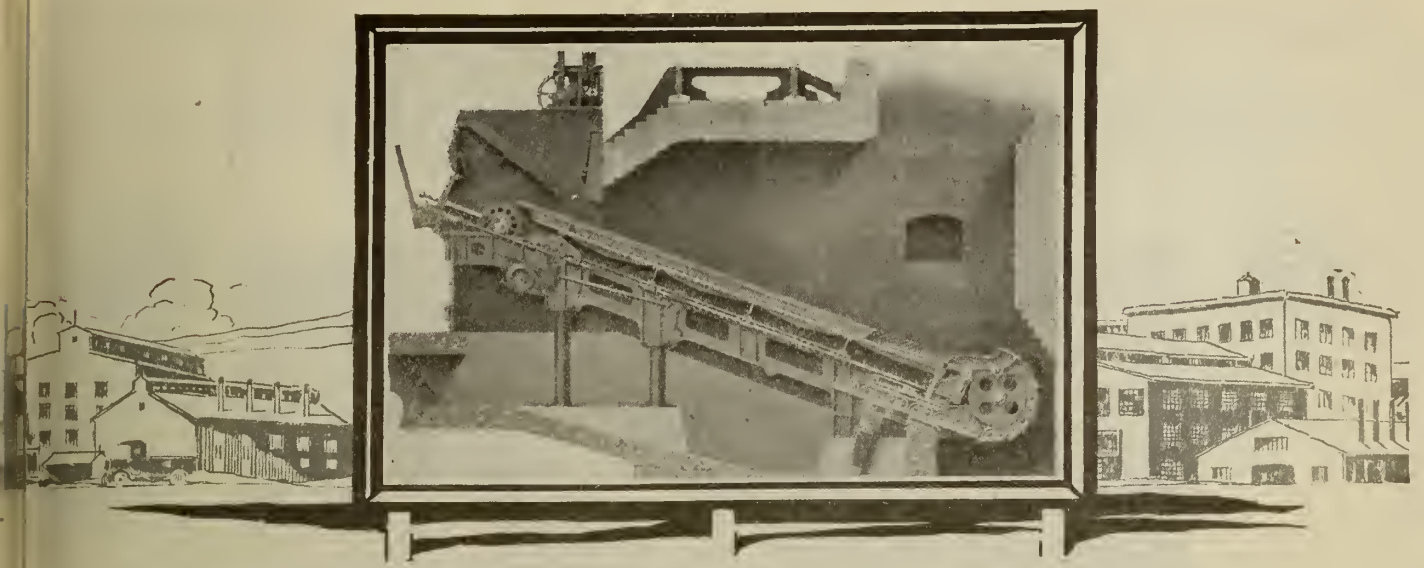
Firms in every industry—firms all over the country—firms using every kind of fuel—are not only buying Laclede-Christy Stokers, but are coming back again and again with repeat orders, the acid test of stoker performance.

Pictured here are the trade-marks of just a half-dozen typical customers who have recently purchased Laclede-Christy stoker equipment. These six are so well-known that it is scarcely necessary for us to give their firm names—their trade-marks immediately tell who they are.

When are *you* going to be numbered among this "Blue Ribbon" list of Laclede-Christy customers?

LACLEDE

A BUSINESS INSTITUTION



The Stowe Stoker—the forced-draft type whose fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit

L-C Stokers?

A REAL GUARANTEE

A guarantee can be worded so as to mean a great deal—or nothing at all. With us, the *spirit,* not the letter of the guarantee, is the vital thing. Briefly, *we guarantee satisfaction to every customer.*

A complaint has never come to our attention that we have not handled promptly and in a manner entirely satisfactory to our customer. We have been in business since 1844. This means that we have rendered satisfactory service in the past. We intend to remain in business for many years to come, which means that we must keep on giving satisfaction.

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Goldie & McCulloch
SECTIONAL WATER TUBE BOILERS

THE above illustration shows in the foreground an installation of two Double Drum G. & McC. Sectional Water Tube Boilers at the plant of the Dominion Tire Co., Kitchener. So satisfactory has been the performance of this installation that two more of the same size and design were ordered to take care of additional Horse Power required.

G. & McC. Water Tube Boilers are designed to give more than ordinarily rapid circulation, increased steaming capacity and maximum overload allowance. All parts subjected to pressure are made of the highest grade forged steel. Write for catalogue, plans, etc.

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POWER HOUSE

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Two Novel Plans for Harnessing Niagara

Two Schemes are Here Described, Original and Daring in Their Conception. One Suggests a Tunnel Through Goat Island, the Other a Gigantic Dam Below the Falls.

By T. KENNARD THOMSON

THE report on a new plan, or rather two new plans, for securing power from Niagara, which is here given, is the work of an engineer of Canadian birth and training.

Mr. T. Kennard Thomson enjoys the honor of being the first Bachelor of Science in engineering to graduate from the University of Toronto. Following his graduation he was with the C. P. R. on construction work, and later went to New York to practise as a consulting engineer.

One of his greatest achievements was the building of the foundations for the Singer Building on Broadway at that time the tallest building in the world. The fact that Mr. Thomson is a practical engineer, with a long and successful record in large undertakings, lends interest to the present scheme. The description of the plans in detail is given below.

Jan. 24, 1921.

To the Honorable Federal
Power Commission,
Washington, D. C.
Gentlemen:

We respectfully beg to submit that the greatest and most uniform and most needed water power resources in the world are in the Niagara River, and that we could obtain the maximum amount of power at the minimum of cost, from any further diversion of water from above the old Falls by our Goat Island plan, and that the best method of developing the maximum amount of power at the minimum of cost in the lower river is by an international dam at Foster's Flats, about 4 miles below the old falls.

While the Goat Island plan will be entirely within the United States, we believe that Canada would readily agree to an international development at that point, as it would obviously save money to the consumers on both sides of the line forever.

Our two projects do not interfere with any of the existing power companies in any way whatever.

Indeed, while we realize that the Governments should control the price for which the power will be sold, we realize the enterprise, the risk and capital which the five pioneer companies put into these original plants, and we therefore think that in fixing such prices, the pioneer companies should be allowed to charge a difference of say $10 a horsepower more than we do, if they so wish.

Neither Mr. Porter nor myself have any financial interest of any kind in any of the present companies.

We realize that no matter what power is sold for, it will always be worth what it cost to develop power by coal.

The cheapest power ever developed by coal in New York City before the war was by the New York Edison and New York Interborough, and it cost them an average of $32.19 a horsepower. That would be equivalent to $70 or $80 a horsepower in the State of New York now, and I was informed in December that it was then costing $90 a horsepower to develop by coal in the City of Toronto.

We can develop two million horsepower at our new dam at Foster's Flats, at a cost of less than $100,000,000 or $50 a horsepower, and can do nearly as well at Goat Island. That means that we could sell for less than $10 a horsepower.

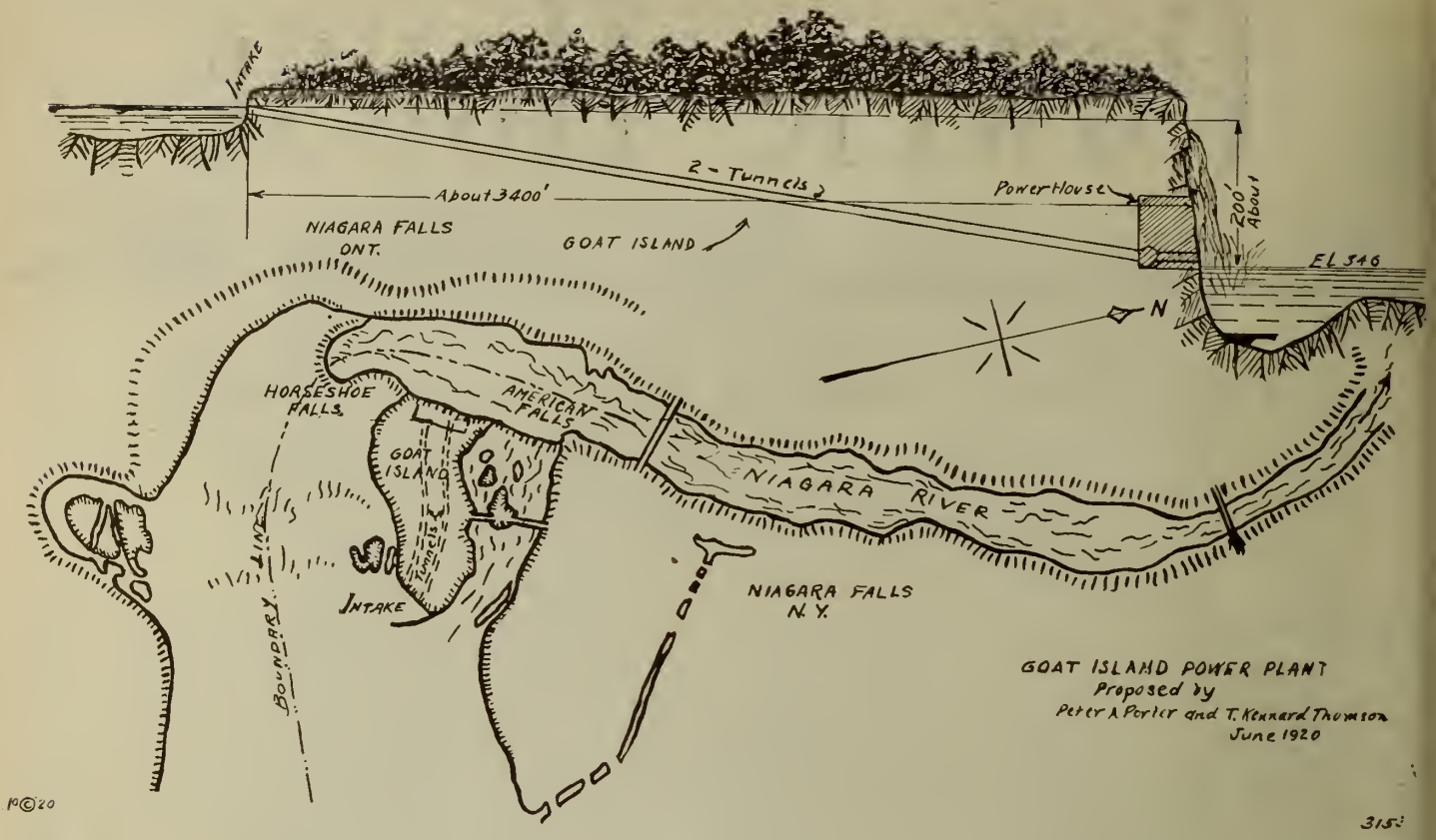
But, as there will never be enough water power to go around, if the manufacturers get our power at $10 or $15 a horsepower, they would have an unfair advantage over their competitors who had to pay $70 or $90 to develop power by coal.

The five pioneer companies developed 650,000 horsepower for $65,000,000 or $100 a horsepower. In doing this they attracted private capital to the extent of $650,000,000 or ten times what they spent themselves.

We claim, therefore, that it will be very much better to allow us to develop power and sell it for use within 100 miles from the site, thereby building up the greatest manufacturing district in the world, than to try to distribute it at long distances with scattering results.

When first I started nearly ten years ago to agitate for this dam, people laughed at the idea that there would ever be a demand for 2,000,000 horsepower. In 1917 I wrote to the director of census, Hon. Samuel W. Rogers, asking him how much power was then in use in the State of New York, and what the normal rate of increase was. He sent me a very comprehensive reply, which summed up that we were then using over 3,000,000 horsepower a year in New York State and that the normal rate of increase was 10 per cent. or 300,000 a year. In other words, half of our dam which would go to the States would only supply one-third the amount of power then being used in the State of New York alone, or would only supply the additional demand for the next three years.

On the other hand I might state that Niagara power is now being distributed in Syracuse, 160 miles away, with a loss of less than 10 per cent. using a voltage of 60,000. By increasing this voltage to 110,000 the power is distributed on the Canadian side of the Detroit River about 250 miles. By doubling this voltage again, making it 220,000, the distance of transmission could again be doubled, making it 500 miles, with the same loss. By examining the enclosed diagram showing circles around Niagara Falls of 100, 200, 300, 400, and 500 miles, which area includes part of nineteen states of the Union and two provinces of Canada and contains 60 per cent. of the entire population of the United States and 80 per cent. of the entire population of Canada, it will be seen that all of these would then be within commercial reach of this power, although, as we have shown above, we



would only have one-third the amount of power required by one state alone.

It might be stated that New York City alone uses between six and seven hundred thousand horsepower a year.

So the people on the frontier, especially in Canada, now realize that they want all the power that they can get developed.

Many people in Canada now realize that our proposed dam in Foster's Flats must be built sooner or later, and that when it is built, every cent spent on the Chippawa-Queenston Canal and similar diversions on either side of the River will have been so much money wasted, and I have not the slightest doubt that the Canadians will see the advisability of scrapping their canal, which I have been told is costing everywhere from $50,000,000 to $100,000,000 for the reason that no other plan or combination of plans will give within 1,000,000 horsepower as much as our dam will. And if Canada has half of that, it would be equivalent to 5,000,000 tons of coal a year at $10 a ton, making $50,000,000 a year. As soon as Canada is convinced, if she is not already convinced that she can get back the $50,000,000 a year, she will not hesitate to scrap the $100,000,000 plan if necessary.

As a matter of fact, however, it would not be necessary to scrap that or any of the other existing plants until they were worn out, but as our two projects are capable of using all the permissible water, such side issues simply add to the cost to the consumer forever. I have taken the liberty, Gentlemen, of going into such detail in the hope that you will not allow further partial developments on this side of the line, to thus add to the cost forever.

In addition, not only would such diversions greatly add to the cost forever, but, we are quite confident that any further diversion of water from the Rapids would result in an ice jam, which would probably destroy every plant in the River. My reason for this statement is that there is hardly enough water now going over the rocks in the Rapids to carry the ice away. As a proof of this statement; some dozen years ago, an ice jam was formed in the Rapids which only lasted eight hours, and kept the water back until it had done considerable damage to the power plants at the Falls, although such plants were at an elevation full 60 feet above the level of the water where the jam occurred, and when the jam broke, absolutely destroyed everything in the river below, all the way down to Lake Ontario for a height of over 20 or 30 feet above the original water level: wharfs, docks, trees, shrubs, buildings and everything being swept away. This jam was caused by a slight change in the wind at Buffalo, which held back the water for a short time, letting the ice pile up on the rocks in the Rapids.

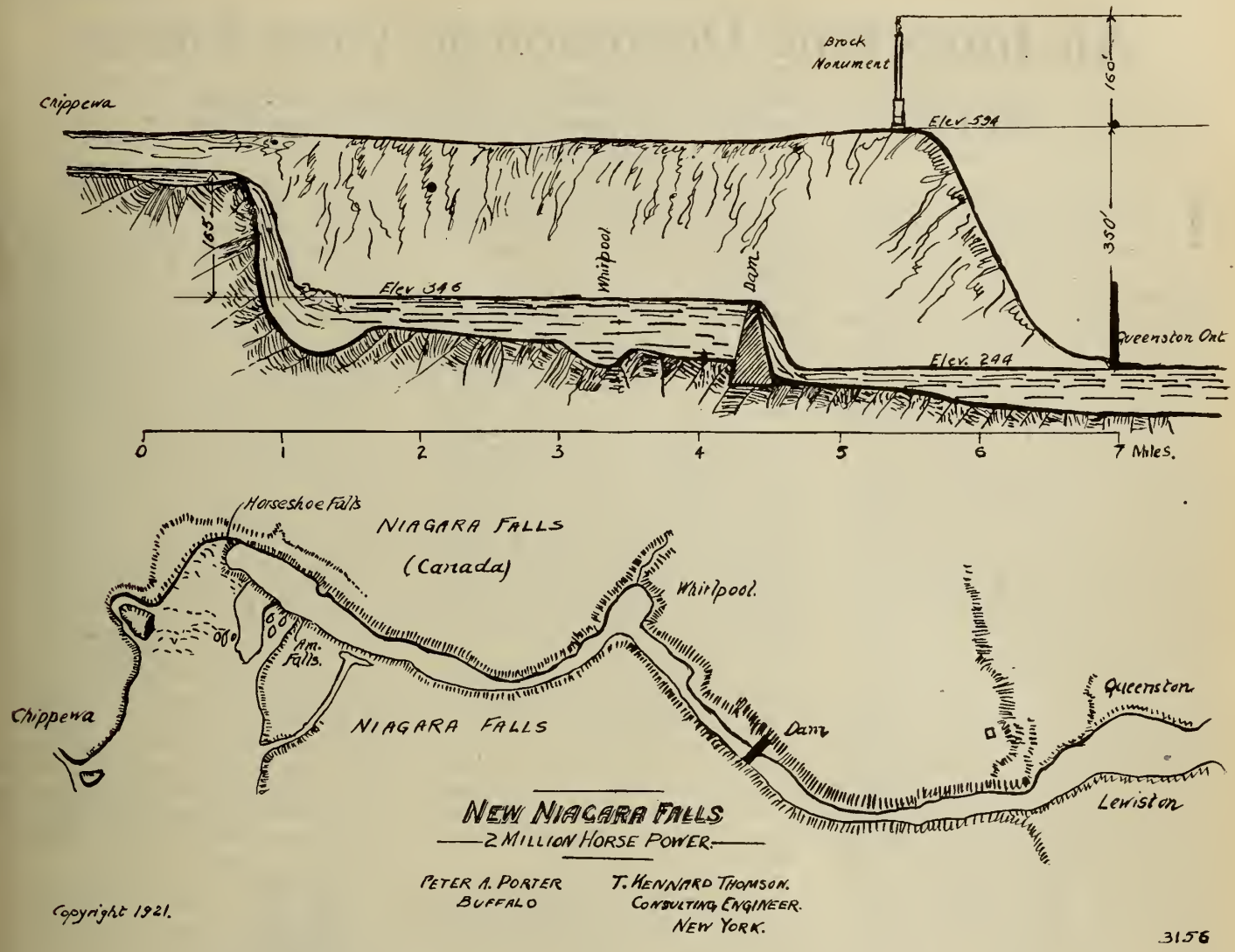
An engineer making as drastic a statement as this should give more than one example. So I go back probably some millions of years, when an ice jam probably diverted the Niagara River, causing it to turn a right angle thereby forming the whirlpool, cutting the brand new channel through the bed-rock.

By looking at the plan, it will be seen what an ideal location Foster's Flats is for the dam, for we can build the first part of the dam on dry land, carrying the base of the dam some 30 feet or more below the bed of the river and then divert the entire river through temporary openings at the bottom of the completed section of the dam, making it a comparatively simply matter then to dam the present channel of the river.

As we propose a dam with very flat slopes, about 700 feet base, it will be a very simple matter to handle the ice, as there will be nothing to prevent the ice from going right over the top of the dam, as there will be no sheer drop on the down stream side of the dam to undermine it, the ice simply sliding off on the flat incline. This design has been called a submerged weir. There will be a minimum depth of 135 feet above the dam and minimum flow of about 220,000 cubic feet per second, so there will be no obstruction arising from the ice.

Goat Island Plan

A glance at the plan will show an inclined tunnel of 2500 feet. It does not need any engineering figures to prove that such a tunnel is cheaper than tunnels five or six miles long or the Chippawa-Queenston Canal which is 12 3-4 miles long. Furthermore, we do not lose the valuable head which, in case of the Chippawa-Queenston Canal, amounts to 16 feet. This tunnel can of course be extended far enough above Goat Island to take advantage of the entire head of the river, at and just above, the old falls, and furthermore it does not de-



stroy any property or scenic beauty on Goat Island whatever.

These two projects together could develop about 4,000,000 horsepower a year, every ounce of which could be readily sold and it would be far better to sell it at the site, thereby developing great manufacturing centres and to pay enormous taxes to Canada and the States, so that all would derive equal benefits instead of taxing all for the benefit of a few.

At the same time the matter of canalization, and power, of the St. Lawrence River should also be started. While it is true that the bulk of the power of the St. Lawrence River belongs to Canada, the United States will benefit enormously by the canalization of the St. Lawrence River, as well indirectly from the development of the power.

For the development of 4,000,000 horsepower in the St. Lawrence River, and 4,000,000 horsepower in the Niagara River, or 8,000,000 horsepower together, or to be conservative say 6,000,000, which is equivalent to 6 million tons of coal a year, will mean that there will be ten Pittsburghs on the frontier. Such developments could not fail to benefit every town, village, and city in the United States and Canada. As a matter of fact, the United States will probably benefit by a 30-foot draft from Montreal to the Great Lakes to a much larger extent than Canada, as our country already has free use of the Canadian canals, and I have been informed often make more use of them than the Canadians. The profile will show that there are five lifts in the St. Lawrence River between Montreal and Lake Ontario, and these might possibly be cut down to 3 or 4.

If the United States and Canada will get together and give us the rights to develop this power, we will give a 30-foot draft to the Great Lakes without charge to either government, and we will develop power, under government supervision as to the plans, construction, operation, taxes, selling price of power and our remuneration.

If this work were done by government ownership in the old sense of the word, God help the countries! On the other hand, it will be inconceivable to give a private monopoly worth $600,000,000 or so a year to any individuals. But if the governments will give us the rights as above indicated, on the basis that we get so much remuneration if we develop power for say $15 a horsepower, less if it costs more than $15 a horsepower and much more for every dollar saved below $15, we would have all of the incentives of a private ownership without any of the objectionable features.

We therefore beg of you, Gentlemen, that you give us permission to develop the Goat Island plan, and that we also beg of you to arrange for an international agreement, treating the entire question as one unit, thereby saving untold millions to the future generations for they will undoubtedly have to pay not only for our two proposed projects in the future, but also for any and all of the minor diversions such as the Chippawa-Queenston Canal or tunnels on either side of the river.

We therefore respectfully state that we think you have it in your power to create the greatest industrial centres in the world, the results of which would be so far reaching that there is scarcely a country in the world that would not be benefited.

Respectfully submitted,

(Signd.) T. Kennard Thomson.

An Interesting Discussion on Valve Effects

The Effect of Various Valve Motions on the Compression and Mean Effective Pressure is Discussed, and a Rotary Type of Valve is Described

THE definite use of the superheater in order to improve the effectiveness of steam in locomotives is of comparatively recent date, having been introduced about 1900. According to Rafford, the idea of superheating steam originated with a mechanic, Francois Becker, who, in 1829, took out a patent for the first superheater on record. Three years later, in 1832, Trevithick took out an English patent for a vertical boiler with a superheater. The principle of construction of superheaters as they are now made is set forth in a patent issued to Quillacq and Monchenil, 1850, which showed the use of U tubes or similar elements placed in a series of fire tubes of large diameter, for the purpose of obtaining a superheat, and put into communication with collectors or headers, placed in the smoke box.

It has been the aim of builders for a long time to reduce the clearance space in the cylinder to a minimum. According to Nadal, the mere reduction of 30 per cent. in the surface of the clearance space, or from an area of five times to three and a half times the surface of the piston, will secure a saving of about 10 per cent. of the total steam consumption per horsepower hour; and, according to Ricour, the substitution of piston for flat valves on the State Railways of France decreased cylinder condensation by about one-quarter, when running with a cut-off at 30 per cent., with the consequent saving of 10 per cent. in steam consumption per horsepower hour as noted above.

The four-valve method of distribution, which forms the majority of improved valve gears, usually effects a wide opening for both the admission and exhaust valves, with a rapid closing of the former, thus avoiding wire drawing at short cut-offs. The steam passages are not bathed in exhaust steam, a fact which tends to reduce condensation on admission; the clearance space can also be made less than with the ordinary valve because of the short period of compression. These several considerations explain why the diagrams obtained with the four-valve method of distribution approach more nearly to the theoretical diagram than those of the ordinary method, and produce an increase of work and efficiency in comparison therewith. In fact, according to M. Nadal, the steam consumption per horsepower hour, on locomotives fitted with them, is 16 per cent less than with locomotives having the ordinary method of distribution, and their speeds on levels and slight grades (except in the case of motions using a dashpot, which do not work well at speeds above four revolutions per second) can be made to exceed the latter by from 3 to 6 miles per hour, other things being equal. This method of distribution is not, however, in extensive use, because of the complications involved.

The piston valves used, in 1882, on the State Railways of France, permit the reduction of the clearance space by the use of very short ports located at the ends of the cylinders. With the ordinary link motion, giving a long compression when the cut-off is short, it is impossible to take advantage of this to any great extent, and the volume of the clearance space ought not to be more than 5 or 6 per cent. of that of the cylinder, and the surface of this clearance space ought not to be more than 30 per cent. of that of locomotives having a plain flat valve, and this fact, as noted above, reduces the steam consumption per horsepower hour by 10 per cent.

With piston valves it is thus possible to make the compressions, to a certain extent, independent of the admission, and so to reduce it by giving the corresponding edge of the openings and the valve a helicoidal form, as well as by giving the valve stems a rotary movement, thus changing the lap and adapting it to the various running conditions.

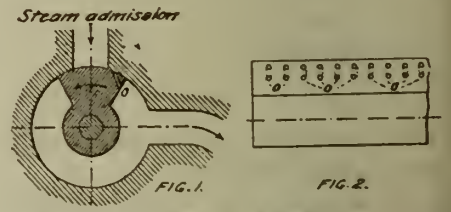
The reduction of the period of compression, on the other hand, depends on the volume of the clearance space, which should also be reduced as much as possible for the sake of steam efficiency; for even if it is filled by compression up to initial pressure, the work done by this steam represents a loss of about 30 per cent. of that done to compress it. If this volume is small, the work of compression will also be small, as well as the amount of condensation; but the final pressure of compression should not be greater than that of admission and it is this consideration which will determine its volume. On the other hand, this same pressure ought always to be sufficient, when joined with the pre-admission, to cause an arrest of the reciprocating parts without shock. The conclusion reached by M. Dwelshauvers-Dery, as a result of his investigations with different degrees of compression, is that operation without any compression would be most economical. We may cite the case of a Van den Kerchove-Bonjour condensing engine of the Corliss type in which an admission of wiredrawn steam is used during compression as shown in Figs. 1 and 2, by means of which the period of compression was reduced to 5 per cent with a clearance space of 5 per cent as shown in Fig. 3.

With the use of the Walschaerts gear, which has been generally applied to locomotives built during the past twenty years, the period of compression increases to an important extent as that of admission decreases, running from 10 per cent of the stroke with a cut-off at 70 per cent. to 42 per cent. when the point of cut-off falls to 10 per cent.

High speeds, at which the cut-off is short, thus still further increase the compression because the back pressure at the commencement of compression is still quite high, amounting to as much as 14 pounds per square inch for a speed of five revolutions per second.

If can be readily understood, that under these conditions a large clearance space is necessary with the link valve gear, and that it should be still more in the high pressure cylinder of compound locomotives where the back pressure at the end of the exhaust may be 25 pounds per square inch or more though the compression may be reduced to a period of 20 per cent. of the stroke. Still the clearance space should be at least 14 per cent of the cylinder volume.

By making the lap of the exhaust valves variable, by the use of a helical form and the rotation of the valve stem, it is possible to reduce the period of compression very materially, and, with



1. CROSS SECTION OF ADMISSION VALVE FITTED WITH OPENINGS FOR PRE-ADMISSION.
2. PLAN OF SAME VALVE.

it, the pressure at the end of the same as well as the clearance space, thus providing for a shorter cut-off while running. It is possible to use a considerable negative exhaust lap when running in this way. But with narrow ports and flat valves such a negative lap presents certain disadvantages, because when at mid stroke or near it, such a valve puts the two ends of the cylinder into communication with each other; so that the steam working expansively at a high pressure on one side of the piston would lose a part of that pressure in passing to the other side, where exhaust is taking place, the pressure of which will be raised by this inflow, causing a second loss of motor work. At high piston speeds corresponding to cut-offs this disadvantage is greatly reduced, even with flat valves, and disappears almost entirely when piston valves, set at the ends of the cylinders, are used with an outside exhaust into separate ports which only come together at some distance from the open-

ing, as is the case, for example, in the compound locomotives with piston valves of the Eastern Railway.

A negative lap of 0.4 inch can be given to the exhaust side of piston valves for high speed running. For full stroke, at the moment of starting, it would be advantageous, on the other hand, to use a lap of 0.2 inch. There is thus a total variation of 0.6 inch which could be made between running at 75 per cent. and 15 per cent. cut-off, so that for each ten per cent. of reduction of cut-off a corresponding reduction of 0.1 inch could be made in the inside lap.

If the actual satisfactory cut-off should be taken as lying between 35 per cent. and full stroke, the limit of variations of the inside lap should be taken between cut-offs of 35 and 15 per cent.

Finally, changes in lap could be obtained by the movement of a second valve placed under the control of the engineer; an arrangement possessed of several advantages for preliminary tests, or automatically, as shown in Fig. 4, which requires no particular attention on the part of the engineer, and when in operation involves no moving parts.

Without being of the same importance, a certain amount of variation in admission lap would also be an advantage. We know that with the Walschaerts and Gooch valve gears there is a constant lead which is not always a logical arrangement. In the United States it is generally considered that, when running with a full stroke cut-off, at starting or at slow speeds, there should be no lead because at the commencement of admission the steam chest pressure would be at once established in the cylinders and that a lead, however short, would be of no advantage and would set up a resistance that would reduce the motive power.

At high speeds, on the other hand, a certain amount of lead is considered necessary in order to fill the clearance spaces with steam at boiler pressure at the commencement of the stroke, and thus obtain a supplementary opening of the ports without which, at short cut-offs and at these speeds, a considerable amount of wire drawing would occur, thus causing a reduction of the average pressure, which would be detrimental to the efficiency and power development of the engine. From this standpoint, then, the lead could be advantageously varied from 0.04 inch or nothing for a full-stroke cut-off, to 0.16 inch or even .25 inch when the cut-off takes place at from 12 per cent. to 15 per cent. of the stroke. A helical outline of the lip of the valve, given a rotary movement when a change of cut-off is made, would make the desired change of lead automatically.

Finally, it is possible to obtain for all points of cut-off, a difficult pre-exhaust and compression lap of the valves (producing, for example, a later exhaust opening and closure at once, while effecting a wider port opening at the same time), by giving the valves a helical movement, resulting from their regular longitudinal movement and a complementary rotation, produced by an articulated crank attached, at one end, to the lower portion of the lap-and-lead lever of the Walschaerts gear, and, at the other, to a small lever mounted on the valve stem.

With the different arrangements indicated above, the rotation of the valves would improve the lubrication and reduce the wear by regulating it.

M. Desdoints, former superintendent of motive power of the State Railways of France, in a study of the power and resistances developed in hauling trains, very clearly set forth the advantages of an exhaust lap that was variable with the speed and, consequently, with the point of cut-off.

"A reduction of the exhaust lap," he said, "has the effect of lowering the curve of motor effect at low speeds and raising it at high speeds." So that the best results for the different speeds of a run will be obtained by using a different lap for each of them, which can be readily obtained by the use of the hand arrangement indicated above. M. Desdoints added, apropos of the lowered efficiency of locomotives at high speeds: "A proper reduction of the exhaust lap ought to have the effect of greatly reducing, if not

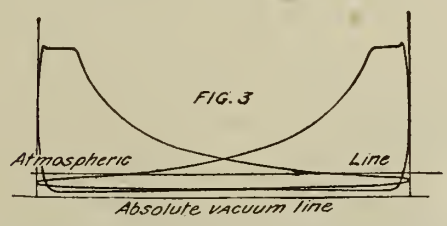


DIAGRAM OF A 300 H.P. CORLISS ENGINE FITTED WITH SPECIAL VALVE SHEWN IN 1 AND 2.

entirely doing away with the lowered efficiency, at high speeds." Finally, in speaking of possible running speeds, he said: "A representative diagram of the tractive effort developed for different points of cut-off, according to the running speed, will make it possible to determine the maximum speeds attainable on a given profile, for a train whose resistance is known: the intersection of the line of this resistance with the curve of tractive effort will give the speed sought. For a given engine it would be impossible to obtain more than belonged to the production of the boiler; but a reduction of the exhaust lap, causing an elevation of the curve of mean effective pressure, should raise the limit of possible speeds."

The use of admission valves with a variable lap would then be a logical thing to use and would secure, at the same time, an increase of efficiency and an improvement in mechanical action. As the superheated steam at high pressure, owing to its high speed of flow, permits the use of short cut-offs of from 12 to 15 per cent. and renders the reduction of compression possible, so that compounding can be dispensed with and simple expansion is thoroughly justified; a point the desirability of which is conceded by all engineers.

The improved methods of distribution with saturated steam will be as economical as compound operation with a flat valve. The advantages and disadvantages of compound operation taken from a comparison of the consumption of sensible and condensed steam in a compound and a single expansion engine, have been set forth by Mr. Vadal, as follows:

The ratio of expansion is usually higher in the first than in the second, except when the latter is fitted with a four-valve distribution, or generally speaking as the comparison is reduced, and this is a benefit, but, on the other hand, there is a loss of area in the compound diagrams because of the transference of the steam, through the receiver, from the high to the low pressure cylinder, and the fall in pressure, which increases with the speed that results. If we look at a totalized diagram of a compound engine, we will see that the admission line of the low pressure cylinder is very much below the exhaust line of the high pressure cylinder, and that a considerable area is thus lost, a loss that has no equivalent in a single expansion engine. This loss, due to transference, is much greater than the advantage obtained by the increase of expansion and results in a greater consumption of sensible steam per indicated horsepower in the compound engine. For example, at a pressure of about 170 lbs. per sq. in. with the cut-off ranging from 10 to 20 per cent. of the stroke, the ordinary locomotive uses from 12.5 to 16 lbs. of sensible steam per indicated horsepower hour, while the compound, between 30 and 50 horsepower, uses from 15 to 17.5 lbs., an increase of about 1.5 lbs. per horsepower hour. At a ruling pressure of 210 lbs. per sq. in. this increase is only about 1.4 lbs. It, therefore, increases as the pressure decreases.

On the other hand, in the compound system, where the expansion is divided between the two cylinders, the amount of steam condensed per horsepower hour is notably less, that is, it is about one-half because it is proportional to the variation in temperature in the high pressure cylinder. The actual advantage of the compound system lies in the difference between the lessening of condensation and the increase in the use of sensible steam. It can readily be seen that this difference may not always be a positive quantity. It may, in fact, be negative if the ruling pressure is too low, that is to say, below 140 lbs. per sq. in., provided the speed of rotation, at the same time, is less than three revolutions per second.

But, for high pressures, there is a positive net gain. For the same average pressure, under ordinary running conditions, compounding effects a saving of from 5 to 6 per cent. with a pressure of 170 lbs. per sq. in. If the pressure is raised to 210 lbs. the saving will be from 8 to 9 per cent.

In locomotives having four valves, as

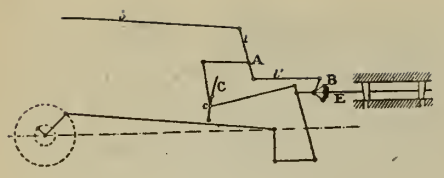


FIG. 4.

General view of valve gear designed by the author having a piston valve with a lap varying with cut off. A, lifting shaft. B, toothed sector for rotating the valve stem. C, link. b, reach rod. c, link block. L, lifting shaft lever. L1, reach rod for rotating valve stem.

great a ratio of expansion can be used as in the compound without having, as in the latter, any special loss in the amount of sensible steam used. But the losses by condensation can only be reduced by reducing the area of the clearance space and the period of compression, which is the essential characteristic of the improved method of distribution. The saving effected in comparison with a single expansion locomotive using a plain flat valve is almost as great as that obtained by compounding.

These conclusions are based upon the result of tests made in service on the State Railway of France on high speed trains, with a State locomotive having piston valves and a Ricour valve gear working under a pressure of 200 lbs. per sq. in. and a four-cylinder compound Midi locomotive using the same steam pressure. The boilers of the two engines were of the same power and they had practically the same weight on their axles. In summing up the matter, Mr. Desdouits says:

"For ordinary express service, the two types of engines develop the same amount of power, but the single expansion locomotive is the more economical of the two.

"For high speed and extra high speed, that is, for trains running at a speed of 62 miles an hour, the single expansion machine holds its own in work done and economy in operation.

"For exceptional work on steep grades or where the weight of the trains is up to the available tractive effort, the compound locomotive will develop more power and will have a lower steam consumption than a similar single expansion engine. But with suitable diameters of drivers the single expansion engine will hold its own."

In the above tests the water consumption of the locomotives having the Ricour gear dropped to 18.6 lbs. per horsepower hour, with a coal consumption of 2.4 lbs., confirming, as Mr. Desdouits says, the efficiency of these engines when working a fast schedule and making from four to five revolutions per minute.

By permitting a reduction of the area of the clearance space, together with a reduction of the period of compression, the use of piston valves having an inside and outside lap that is variable with the point of cut-off, the thermic and mechanical efficiency of these locomotives can be still further improved. Finally with super-heated steam, which is favorable to the use of the short cut-offs that are possible with high pressures, a most satisfactory general efficiency can be obtained with a valve mechanism quite as simple as that used in the compound system. —L. Pierre-Guedon in Le Genie Civil.

AUTOMATIC LIGHT AND POWER STATION

There has recently been placed in operation by the St. Paul (Minnesota) Gas Light Co. an automatic substation supplying power to the Edison three-wire distribution system. The equipment in this station, which is of Westinghouse manufacture, consists of a 500 KW, 250-125 volt direct-current compound, commutating pole, compensated generator directly connected to a 4,000 volt, three phase, 60 cycle, 1,200 r.p.m. synchronous motor, together with complete automatic switching equipment.

This substation is located in the subbasement of the new Hamm Building, which houses the large new and beautifully modern Capitol Theatre devoted to the cinema art. Also in addition to many shops and floors of offices, there is operating in the first basement the St. Paul Amusement Co., devoted to bowling and billiards.

To supply this establishment with service from the light company's network, it would require not only additions to the capacity of an existing substation, but the addition of copper to the distributing network as well. In the nearest substation no space is available for the installation of an additional unit. The automatic substation, designed to give to this building a preferred service, solves the problem. During periods of light load, the substation is idle, the building being supplied from the Edison voltage below a predetermined value, the equipment receiving a starting impulse from a contact-making voltmeter, puts the substation into service. Operation of the station is continued until the load drops below a predetermined value and remains at or below this value for a given length of time, when the station is cut out of action by the action of a small motor operated timing relay. The system direct-current voltage is now above the setting of the contact-making voltmeter, so that the station remains idle until the dropping network voltage indicates further demand.

While the substation is in operation, it is paralleled with the network until the current to it is in excess of one-half the capacity of the machine, when a small amount of resistance is cut into series with the feeder, thus dropping the voltage to effect a dropping of load. This is accomplished by the functioning of direct-current, reverse current relays controlling the operation of the electrically operated contactor switches. When the substation is idle, the current inflow to the building from the network is not limited. It is thus seen that this building receives a preferred service. An outage on the direct-current network leaves the building to be supplied from the substation. Conversely, an outage of the substation leaves the building to be supplied from the network. This combination thus establishes very good voltage regulation of the service supplied to this location.

Protective features similar to those supplied for railway automatic substations and other features peculiar to this type of equipment afford complete protection to the apparatus. The success of this equipment as shown by the initial operation is already assured. It demonstrates a new application of automatic switching which opens the way to perhaps even a greater field than any that has so far been entered with this class of apparatus.

NONCONDENSABLE GASES IN REFRIGERATION MACHINES

(Abstract of Technologic Paper of the Bureau of Standards No. 180, by E. C. McKelvy and Aaron Isaacs.)

In the experiments conducted at the Bureau of Standards the conditions existing during the operation of an ammonia absorption refrigeration machine were duplicated. It was found that the presence of the noncondensable gases that cause so much trouble in the operation of these plants is due to either or both of these causes: (1) Leaks of air into the system, and (2) the corrosive action of the aqua ammonia on the metal of the plant.

If the "foul" gas is mainly nitrogen, the gas is derived from air that is leaking into the system. The oxygen originally present in the air is quickly used up when the plant is operating and so will be present in only a very small percentage of its original amount. If the foul gas is hydrogen, the cause is corrosion by the ammonia liquor. Pure aqua ammonia will not cause gas formation; but if salts of such weak acids as acetic or carbonic acid are present in the "aqua," the corrosive action will continue during the life of the charge. If the gas contains both nitrogen and hydrogen, both causes are present.

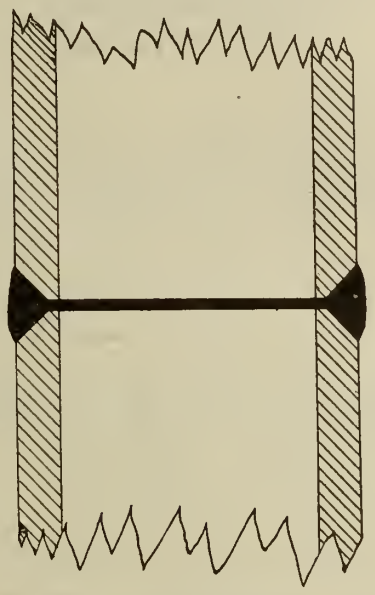
The corrosive action of impure aqua may be completely stopped by the addition of either sodium or potassium dichromate to the aqua in the plant. The dichromate is conveniently added in the form of a concentrated solution, and gas formation will be stopped if the salt is added to the extent of 0.2 per cent. of the weight of the aqua present.

The Hanson Clutch & Machinery Co., Tiffin, Ohio, announce that their new General Catalogue C-3 is completed and now ready for distribution. This booklet will be a handy reference for anyone using or contemplating using friction clutches, as it is complete in every detail. Hanson friction clutches meet a very large range of power and transmission problems.

A Steam Pipe that is Over 1,000 Feet Long

An interesting job in oxy-acetylene welding is being carried out in connection with the installation of the heating plant for the Toronto Union Station. The steam pipes are being brought from the steam power plant of the Toronto & Niagara Power Co., which is distant from the station about one-quarter of a mile, and the joints are all being made by the welding process.

Two pipes are being installed, one eight inch diameter and one four-inch diameter, the larger one being for winter use, and the smaller for the summer months. They are both high pressure lines, being designed for a pressure of 200 pounds per square inch. They are being laid in an eight feet deep trench, the pipes being carried on rollers, which are laid in brackets on a concrete foundation. Expansion joints are installed at about every 200 feet. When completed, the trench will be filled in, the only access being left at the expansion joints, where a manhole will be left at each one, for inspection purposes.



SECTION OF PIPE SHEWING WELD

Owing to the size of the pipes, they have to be welded in place, and this of course necessitates that half of each weld has to be made from the bottom side, or in other words, is an overhead weld. Needless to say, to perform this properly calls for considerable skill on the part of the operator.

In order to facilitate the welding the pipes were chamfered at the mill, and the cut shows very clearly this chamfering. During the welding the pipes are left one-eighth of an inch apart, to insure a solid weld being obtained.

The success of this job will no doubt give an impetus to the welding of underground steam pipes, as being a permanent job, with no chance of gaskets blowing out. The work is being performed by the Carter Welding Co., of Toronto, who are well known in this line of work. The work is being performed to the satisfaction of the Ontario Boiler Inspection Department.

A VIEW OF THE WELDING OPERATION

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

BEFORE proceeding further with the study of the indicator card, in its relation to the distribution of steam, it is advisable to look into the action of the apparatus which controls that distribution. We can then better understand what we shall learn from the indicator card.

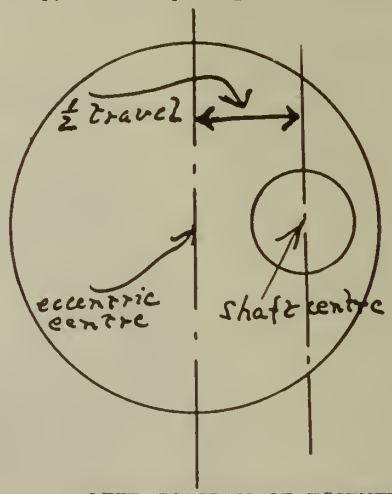
Steam distribution in an engine cylinder is affected by the use of valves, either sliding or rotary, operated by the motion of the engine itself. The valve most generally in use is the slide valve, in its various forms, with the semi-rotary valve of the Corliss type probably second, gridiron type slide valves like the Wheelock or MacIntosh Seymour being in fairly wide use, and poppet valves of the Brown type also having many users. Some of the leading Continental makers use the poppet type of valve, in conjunction with superheated steam. The Uni-Flow type of engine uses a poppet valve. These different types of steam distribution valves are actuated either by an eccentric on the crank shaft, or by means of cams mounted on a shaft which is driven by bevel gearing from the crank shaft. The motion is always derived from the engine itself, in some types being actuated by rods without the interposition of an eccentric or cam shaft, these gears being known as radial gears. The locomotive type of valve gear is a noticeable example of these latter gears.

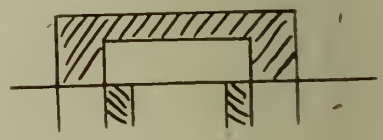
In the vast majority of stationary engines the eccentric is in use, and once having a good knowledge of the action of a slide valve operated by the usual eccentric, it is easier to follow the other types of gears.

The Eccentric and Slide Valve

In the early steam engines of Watt, it was necessary for a boy to stand at a lever and move the steam valve backward and forward to keep the engine in motion. It is to one of these boys that the invention of the eccentric is credited. Being like most boys, inclined to play rather than work, and finding his job somewhat monotonous, he cast about for a means of relieving himself of some of it. He suddenly hit upon the idea of attaching a rope to the end of his lever, attaching the other end to a moving part of the engine in such a way that it gave the desired motion to the valve. It was from this that the eccentric was developed. The eccentric is simply a form of crank, but it has the advantage that it can be put on the shaft at any portion of the length, can be made in halves if necessary, and can be turned round on the shaft to any position independent of the connecting rod or eccentric rod which it works. It is called an eccentric because its centre is eccentric to the centre of the crank shaft, instead of concentric, and it is the amount of this eccentricity, or the distance from the centre of shaft to the centre of eccentric that determines the travel or stroke of the eccentric. The diameter of the eccentric sheave or pulley itself has no bearing on the length of its travel. The distance from the centre of shaft to centre of eccentric corresponds exactly to the distance from the centre of shaft to the centre of crank pin in an ordinary crank. The illustrations herewith make this clear.

If we now place around this eccentric a ring or strap, which is able to slide, or allow the sheave to slide around inside it and let the eccentric be keyed to the shaft, while the strap is held at one point; if the shaft be now revolved, the eccentric will give a reciprocating motion to the strap, and to the rod fastened to the strap, thus completing the similarity





LEFT—DIAGRAM OF ECCENTRIC. RIGHT—VALVE WITHOUT CAP

to the ordinary crank and connecting rod. The eccentric pulley or sheave is the crank pin, the strap and rod form the connecting rod and crank pin bearing, while the valve spindle takes the place of the piston rod. Thus while the crank and connecting rod are changing the reciprocating motion of the piston into the circular motion of the crankshaft, the eccentric sheave strap and rod are changing the circular motion back again to the reciprocating motion of the slide valve, which is controlling the distribution of steam to the piston.

The steam distributing valve or slide valve we are now considering has to perform the functions for each end of the cylinder in a double acting cylinder, and these functions are four at each end. It must control the admission, cut-off, release, and compression of the steam during the outward and inward stroke at each side of the piston. As the steam is exhausted from behind the piston through the same passage as it is admitted by, at each end, the problem was to keep the cylinder alternately in connection with live steam and the atmosphere or condenser, and in order to do this the slide valve was evolved.

The slide valve in its simplest form consists of two flat plates joined together by an arch, the spring of the arch forming a cavity for the escape of steam, and the flat plates forming the means of opening and closing the passages to the cylinder as they moved across them. The only difference in slide valves is that in the larger ones in order to get a good port opening with small travel, they are made double and sometimes triple ported. These will be explained later, as will the piston valve, which is only a modified form of slide valve.

As we now have seen the means empoyed for moving the slide valve, and have an idea of the functions of that valve, we can go ahead and find out some more about it.

The steam chest face has three openings into it, one at each side leading to opposite ends of the cylinder, and the centre one communicating with the exhaust passage. The simple form of slide valve would have to be of sufficient width to just cover these openings when in its middle position. It would then have to have enough travel to move far enough on each side of the centre line to uncover the ports first to steam and then to exhaust, or in other words, to put the cylinder first in communication with the steam chest, and then with the exhaust

passage. From this we see that the amount of travel that would have to be given to the valve would be equal to twice the port opening. Then the stroke of the eccentric would be two port openings, and the amount of eccentricity, or distance from centre of shaft to centre of eccentric would be equal to one port opening.

Now in order to admit the steam to the cylinder at the proper moment the valve must be in a definite position in relation to the piston, and the eccentric must be in a definite position in relation to the crank. What must those positions be? A little thought will soon show that when the piston is just beginning its stroke, the valve must be just on the point of opening the passage to steam. Now when the valve is in its mid position it is just covering the ports. Therefore we must have the valve at midstroke just as the piston is at the beginning of the stroke. That means that the crank which drives the valve, or the eccentric, must be at its mid position when the engine crank is at the beginning of its stroke. As the full stroke of the crank sweeps through 180 degrees, the eccentric must be half that number of degrees in advance of the crank, or 90 degrees. Thus we have the position of the eccentric for a simple slide valve having no lap or lead. In a valve of this kind steam will be carried the whole length of the stroke. This is not conducive to economical working, so that in order to get an earlier cutoff the valve must be modified somewhat.

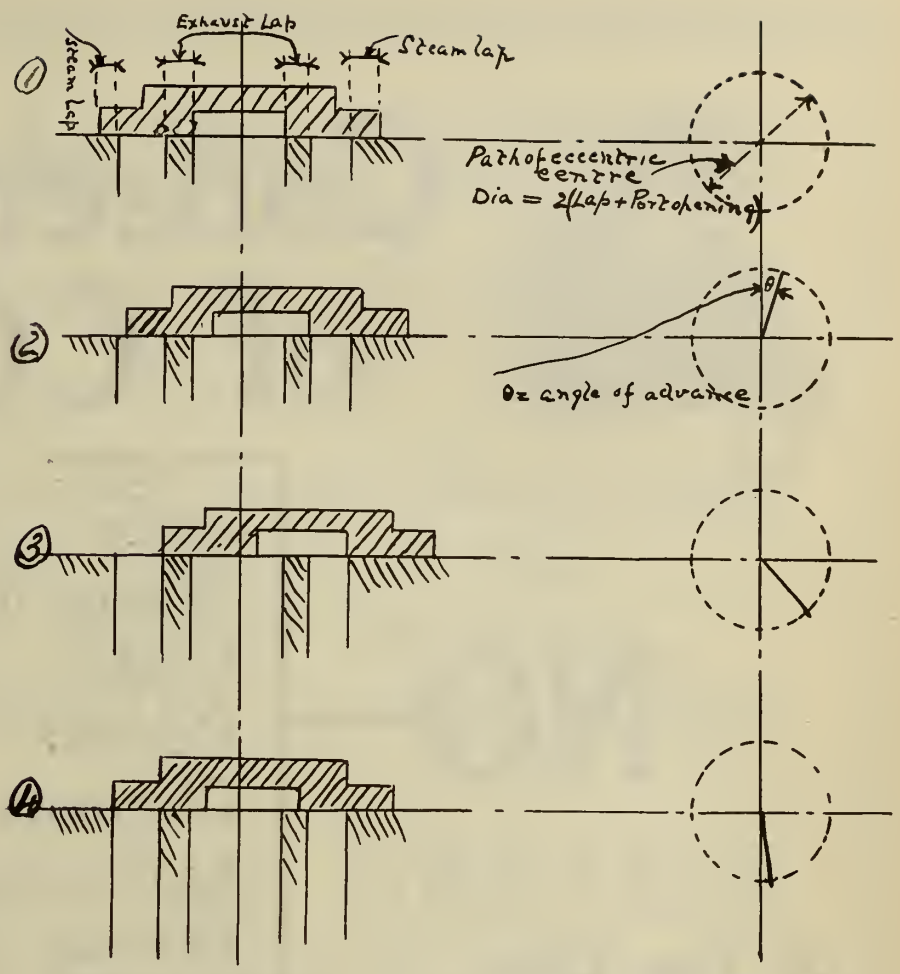


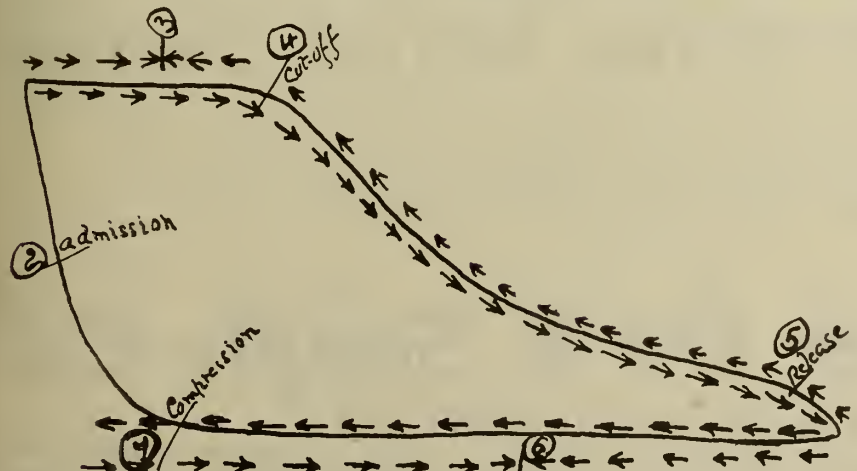
DIAGRAM SHOWING POSITION OF VALVE AND ECCENTRIC THROUGHOUT STROKE.

Steam Lap

Looking at our simple valve it becomes evident that the outside edge of the valve at each end governs the admission and cutoff of steam, while the inside edge effects the release to exhaust and the closing to exhaust. We therefore see that if we wish to have the cutoff take place at any time less than full stroke we have got to do something with the edge of the slide valve that governs the steam supply. What we want to do is to have the steam admitted at approximately the same time, but we want to effect the cutoff at say about three-quarter stroke. That means that our valve must start to travel backwards earlier than it did so as to cover the steam port when the piston is at three-quarter stroke. But another difficulty arises if we succeed in that. The exhaust port will be opened at practically the same time and thus there will be no benefit from the expansion of steam, and we will merely have less work without any economy.

In order to get over these difficulties, the faces of the valve are made longer, so that they project over the ports a certain amount when the valve is in mid position. The amount that they project beyond the outside edge of the port is known as the steam lap, while the amount on the inside is known as exhaust lap. Now the immediate result of putting this lap on the valve is that when the piston is at the beginning of its stroke, the eccentric being 90 degrees ahead of the crank, the valve will not be in position to open to steam. Obviously, we must bring it into position by turning the eccentric still further ahead of the crank, an amount sufficient to bring the edge of the valve to the edge of the port. It is usual to bring the edge of the valve a little bit past the edge of the port so that when the piston is starting its stroke the valve has already opened a certain amount, and this amount is called the lead of the valve. Thus we have moved the eccentric from its original position at 90 degrees ahead of the crank to a position as much further ahead as the combined amount of the lap and lead of the valve. This further angle we have moved the eccentric through is known as the angle of advance. Thus the total amount an eccentric is placed ahead of the crank will be 90 degrees plus the angle of advance.

Having gone this far, we are now in a



OUTSIDE ARROWS SHOW DIRECTION OF VALVE. INSIDE ARROWS SHOW DIRECTION OF PISTON. NUMBERS CORRESPOND TO NUMBERS ON DIAGRAM SHOWING VALVE POSITIONS.

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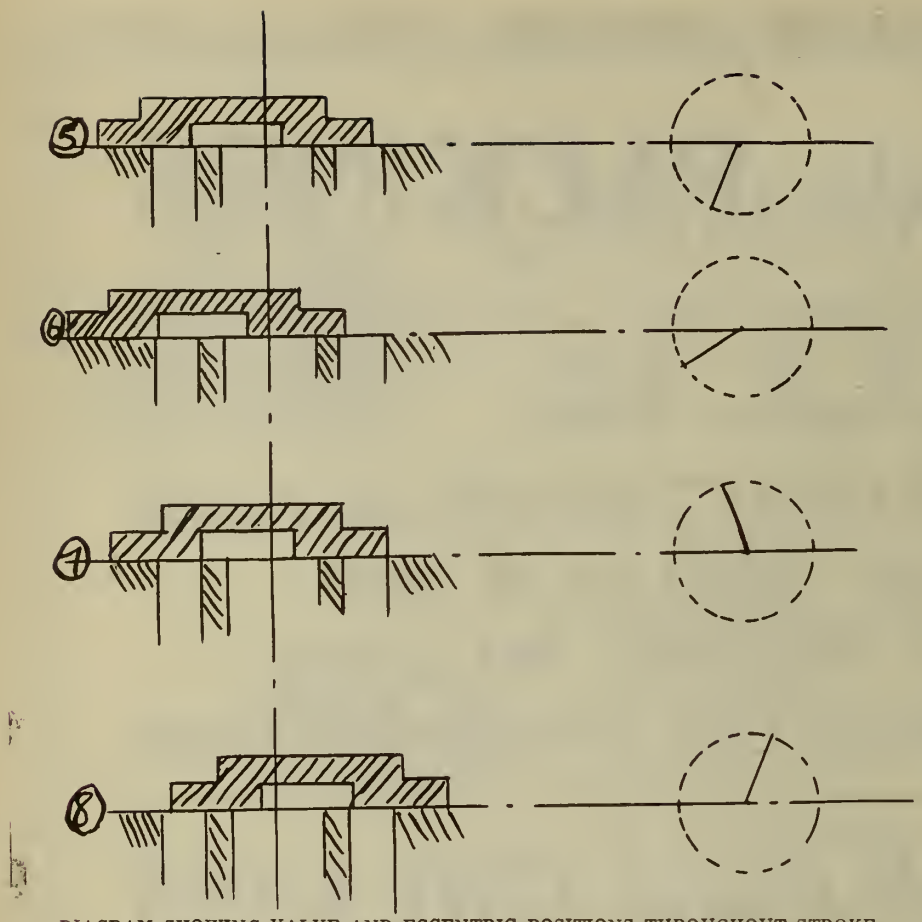

DIAGRAM SHOWING VALVE AND ECCENTRIC POSITIONS THROUGHOUT STROKE.

position to follow the valve through a complete revolution of the crank shaft, and observe the performance of the different functions. We can also draw a card to correspond to the various points of steam distribution and thus get a very clear idea of the valve motion and its effect on the diagram.

Starting with the piston at the beginning of its stroke, and the valve open the amount of the lead, the piston moves out, and the valve moves in the same direction until the port is open the full amount, when the eccentric is at the extreme point of its travel. The valve then moves in a direction opposite to the motion of the piston until the outside edge of the valve covers the steam port, when cutoff takes place. The piston continues to move outwards, and the valve inwards, until the inside edge of the valve uncovers the inside edge of the port, when release takes place. The piston moves on a little way further to the end of its stroke, the valve still moving the opposite way until the exhaust opening is at its maximum. The piston by this time has reversed its motion, and the valve starts on its return, covering the exhaust edge of the port and effecting compression while the piston is still moving inwards. When the piston is not quite at the end of its return stroke, the valve has moved forward far enough to uncover the steam port, until when the piston is at its extreme travel, the valve is again open to lead, and the revolution is complete. The same action takes place on the other side of the piston, so that by following the movement on one side, we get all the necessary information.

The amount of exhaust lap as shown in the diagrams is rather more than would be the case in practice, but the sketches do not pretend to accuracy, but are merely for the purpose of following the motion of the valve throughout a stroke. The proper proportions of valve can be determined by means of a diagram, which we shall explain in due course.

The foregoing allows us to make some definitions which are easy to remember, and important enough to be worth remembering.

Eccentricity=Distance from centre of shaft to centre of eccentric.

Travel of Eccentric=Twice the eccentricity=2(Lap plus Lead).

Steam Lap=Amount valve projects over outside edge of port when in mid position.

Exhaust Lap=Amount valve projects over inner edge of port when in mid position.

Lead=Amount valve is open to steam when piston is at beginning of stroke.

The four cardinal points of the valve function are Admission, Cutoff, Release, and Compression. The first two are controlled by the outside edge of the valve and the latter two by the inside edges. We will consider the setting of various forms of valves and the effect of wrong setting on the indicator cards, also the determination of clearance by the card, etc., in subsequent lessons.

Catalogues

Announcement is made by the Atlas Valve Co., Newark, N.J., that in rounding out their line of high grade valves—reducing valves, pump governors, pressure regulators, hot water regulators, control valves, damper regulators, etc.—they have now added the "Ideal" automatic pump governor, having acquired sole patents and rights to manufacture by purchasing from the Ideal Automatic Manufacturing Co. This pump governor has been approved by the United States Navy and by National Board of Supervising Inspectors of Steam Vessels for controlling certain exacting operations.

"Ideal" automatic governors are constructed either to maintain a constant pressure or to permit of variation of the pressure as desired. They are used for controlling automatic fire sprinkling system pumps, elevator pumps, turbine step-bearing pumps, hydraulic pumps, ammonia, gas and air compressors, and any other apparatus requiring sensitive reliable automatic pressure control of steam, water or pneumatic power.

We have received a bulletin describing the Yarway-Lea V-Notch meter, made by the Yarnall Waring Co., Philadelphia. This meter is adapted for use as a boiler feed water meter, and it is claimed that it is accurate to within 1½ per cent. of the actual weight of the water with any variation of temperature or flow. The meter in general design consists of a cast iron casing, which contains two chambers, the top one containing the V notch and the lower one being used as a storage chamber. There is a float in the lower chamber, operating a balanced valve, which controls the admission of water to the upper chamber, thus ensuring a regulated flow to the notch. The recording mechanism provides four kinds of information: Inches of head falling over weir, instanteous indication of rate of flow, graphic record in pounds or gallons during any part of twenty-four hours, or total weight of water between any two readings.

We have received the new catalogue of the Coppus Turbo Blower, manufactured by the Coppus Engineering and Equipment Co., Worcester, Mass. The new booklet gives some interesting comparisons between forced and induced draft, and then gives a clear and well illustrated description of the Coppus blower. The various parts are shown in detail, and some illustrations of plants are included where installations have been made.

TRADE ANNOUNCEMENT

The Great Western Contracting Co., Kansas City, Mo., representatives for the Conveyors Corporation of America, Chicago, have changed the name of their organization to the Rawlings Industrial Equipment Co.

U. S. RECOGNIZE BRITISH EXPERT

Sir Robert Hadfield Brought Out Steel of Great Use During War

Sir Robert Hadfield, inventor of manganese steel and leader of the British steel industry, has been awarded the John Fritz gold medal for notable scientific and industrial achievement, it was announced by the John Fritz Medal Board, of New York, representing five leading United States engineering societies. Manganese steel was first described by Sir Robert in 1893, but it did not become generally known until the war demanded armaments in which toughness was combined with great strength. Manganese steel is non-magnetic, and millions of helmets made of this material were worn during the war by British, United States and Belgian soldiers. In addition to inventing manganese steel, Sir Robert discovered a magnetic steel of high permeability especially suited for use in dynamos and motors.

HAMILTON LODGE C.A.S.E.

The educational committee of the Hamilton Lodge of the Canadian Association of Stationary Engineers have obtained the loan of the new lantern recently purchased by the Grand Lodge of the Order and on February 7 they intend delivering an illustrated lecture on A.C. and D.C. generators and motors. The lodge are actively engaged in a campaign for the acquisition of new members and are making their meetings of such an attractive nature that they feel they will have little difficulty in the matter. At the last meeting a resolution of condolence was passed expressing the sympathy of the lodge with the widow of the late secretary of Toronto Lodge, Mrs. F. C. Harding.

ADVANTAGE OF REDUCED GRATE AREA

Editor, The Power House:

In your December issue of the Power House, page 538, you give some notes from one of my lectures on the establishment of a standard ratio between grate area, gas outlet area from the rear end of the furnace flues and area of chimney. On the second column, third paragraph, you state, "During the last few years many old boilers have been fitted with parallel flues, etc."

The sentence should read as follows:

"During the last few years we have replaced with modern Lancashire boilers many old boilers having parallel flues. Two of such boilers 8 feet diameter are now in our yard, the flues 3 feet in diameter, which is 2 inches less at the front end than in the modern boiler of the same shell diameter, but 4 inches larger in diameter at the back end, but the old type will evaporate 15 per cent. more water per hour than a boiler of modern design and under exactly similar conditions."

W. H. CASMER.

FUELS ON RAILWAYS

Important trials with pulverized coal and "colloidal fuels" have been carried on the Great Central Railway, England. Colloidal fuel is powdered fuel suspended in thick oil, and pulverized coal is dry coal reduced to a fine dust. The trials, which were made in comparison with ordinary coal, showed that the special fuels could easily maintain a full head of steam with a high degree of superheat, even on heavy gradients and sharp curves. Locomotives adapted for burning pulverized coal or colloidal fuel show an economical freedom from ash-pan cleaning, smoke-box cleaning and repairs, fire cleaning, and so on. Further, when the locomotive is delayed in a siding there is much less waste of fuel than in the case of ordinary engines.

DRILLING HOLES IN GLASS

You can drill small holes in glass with a diamond point resembling that used for china riveting, or with a dead hard steel drill, says Practical Engineer. Use a lubricant of turpentine or oil of spike. Large holes can be rapidly made with a piece of copper tube having a serrated edge fitted with crystals of carborundum. It is not the hardness of the glass that causes the trouble, but the heat created by the friction of the drill. It will be found preferable to leave the glass in cold water where the experiment can be carried on, the water preventing undue heating with the consequent fracture of the glass.

C. H. N. Connell, district engineer of the Canadian National Railways, has been promoted to the position of district engineer at Toronto, with jurisdiction over all lines in Ontario. Mr. Connell became associated with the C. N. R. in 1909, when he was appointed engineer of maintenance of way over the Quebec division. In 1914 he was appointed divisional engineer and promoted to district engineer in the early part of 1918.

Walter Lambert, naval architect, 14 Place Royale, Montreal, is now getting prices from Canadian shipbuilders for motor barges for carrying pulpwood and specially designed for shallow draft conditions for mechanical unloading. It is expected, provided prices are acceptable, that contracts for same will be placed immediately, in which case ships will be in service in the St. Lawrence during the coming season, and being of special type will doubtless attract considerable attention. Mr. Lambert hopes at a later date to be in a position to publish plans and specifications of these ships.

ANNOUNCEMENT

The Combustion Engineering Corporation announces the opening of a branch office in Atlanta, Georgia. This office has been placed in charge of Mr. A. A. Hutchinson, who has had an extensive experience in the engineering field and is widely known in the South, having been actively engaged in the field of combustion generally for the past fourteen years and during that period been in charge of important development work.

The Potomac Electric Power Company which operates a number of large power stations in the vicitity of Washington, D.C., employed him as a construction engineer and superintendent of the underground testing department, in which capacity he assumed full charge of several large substations. Mr. Hutchinson later was given charge of the entire testing department. His later experience in the designing, equipping and operating of large power plants has given him an excellent foundation for understanding the requirements of stoker prospects and users with whom he will come in contact in his new capacity.

The Combustion Engineering Corporation believes that Atlanta is a strategic location for handling its southern business and with this office definitely established in the heart of the city at 521 Candler Building, it will be in a position to promptly and efficiently handle any combustion problem in the South.

The Canadian Pacific Railway has announced its intention to offer two free scholarships, covering four years' tuition in architecture, chemistry, civil, mechanical or electrical engineering, at McGill University. The scholarships are open to apprentices and other employees under the age of twenty-one. The necessary requirement will be the passing of the regular entrance matriculation examination provided for in the annual calendar of the University, and the two candidates receiving the highest averages and complying with the requirements for admission will be awarded the scholarships and have the option of taking any of the above courses. Rules governing the continuance of the course provide that the holder shall meet the necessary requirements for the next higher year. Interruption to studies may be granted by giving due notice to the railway company.

Build Coke Plant?—The Semet-Solvay Co., the largest concern of its kind in the world, is considering building a four million dollar by-product coke oven plant at Hamilton, it is announced. It is said this would produce all the artificial gas necessary to meet Hamilton's needs for several years.

Will Develop Plant.—It has been reported that the United States Steel Corp. has voted $291,420 for the extension of the Essex Terminal Railway for running several spurs from the main line of the route into the plant of its subsidiary, the Canadian Steel Corporation.

POWER HOUSE

Member of the Audit Bureau of Circulation

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An Ambitious Proposal

IN this issue of Power House, two schemes which together would be able to utilize the full amount of water available at Niagara and develop between them 4,000,000 horsepower, are described. They are proposed by T. Kennard Thomson, an engineer of wide reputation and achievment.

The two schemes are briefly the cutting of two tunnels through the rock of Goat Island to carry water from the head of the falls to a power house situated at their base, and secondly the erection of a huge dam at Foster's Flats, just below the whirlpool rapids, with a power house below. The combination of these two schemes would give the 4,000,000 horsepower promised. By the canalization of the St. Lawrence a further amount of power could be obtained which would bring the total up to 6,000,000 horsepower and create a great manufacturing centre on each side of the river to the immense benefit of both countries.

The working out of the plans it is suggested should be done by private enterprise, but working under an arrangement by which they could be rewarded according to the cost per horsepower of the power they furnished. That is the cheaper the power supplied to the public the more the power owners would receive. In this way the promoters would have all the incentive to supply power as cheaply as possible and the evils of both government ownership and entirely private ownership without control would be avoided.

The scheme is a big one and requires to be viewed with a total absence of bias. That it is sufficiently practicable to require careful consideration by the governments of both countries seems to us to be obvious. With regard to the existing power houses, it is suggested that they could remain in operation until worn out, but that they would never be replaced, as the entire supply of water could be utilized by the scheme proposed. The money spent on the Chippawa Canal would be lost, but the saving made possible by the generation of enormous amounts of cheap power would more than make up for that.

We wonder what Sir Adam Beck thinks of it and especially the suggestion that the Chippawa Canal should be scrapped at once to save further loss on a scheme soon to be obsolete?

How Could He Do It?

A CORRESPONDENT, after reading an account of a fatal boiler explosion, expresses wonder that a man could be so careless as to light up a furnace without first ascertaining the water level.

This may well seem a strange proceeding, when looked at from the standpoint of the man of average intelligence, but it is just these dangerous lapses from standard, careful practice that account for many of the accidents happening from day to day. It is against carelessness of this kind that the chief engineer of a plant has to guard. He may take every possible precaution, and still be let down by the lack of interest of some one man on his staff, who does not realize his responsibility. Every chief engineer of a plant that employs a night staff has had the experience of being called from his home or from his bed by an S.O.S. from the plant and most of them have found on these occasions that the use of a little common-sense on the part of the night staff might have saved him that trouble. There are, of course, situations that arise that really call for the presence of the chief, but more often than not it is otherwise.

There is again the man who is just foolish, who wanders down into the boiler room and monkeys with things he does not understand. A case of this kind is reported in the Montreal press, where the result was fatal. Some idiot, who should be locked up out of harm's way, went down into the boiler room of a plant and threw a quantity of photographic flashlight powder into the furnace. The explosion that followed caused the death of the fireman and the severe injury of several other persons in the vicinity, among them the thrower of the powder.

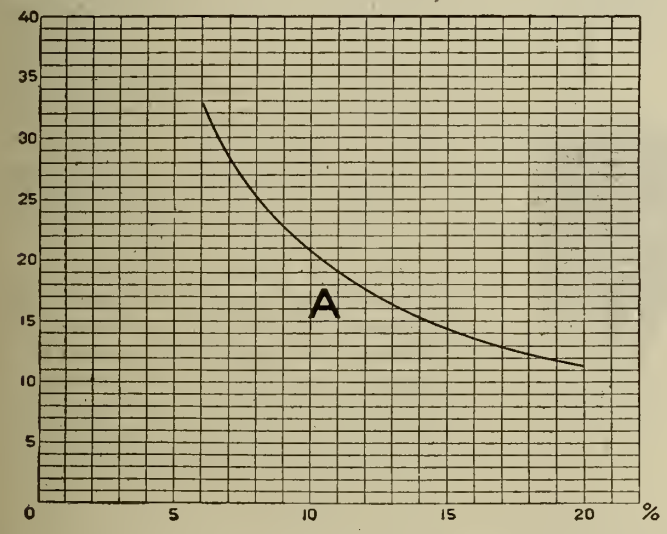
It seems hard to believe that men can be so utterly without sense or thought as to do these things, but we must believe the evidence when we see it. Of all the various mechanisms going to the make up of a power plant, the one unknown quantity still remains. That is the human element. It is an indeterminate quantity and the most reliable of men are sometimes attacked by a species of aberration which leads them to do things they would never do in the ordinary course of events.

In a power plant the secret of successful operation is eternal vigilance, not only on the part of the chief, but of everybody on the job. This "safety first" stuff is not a bad thing to follow out, even if it is sometimes presented in a ludicrous manner.

Progress in New Equipment

A NEW SYSTEM OF GAS ANALYSIS

The Mono Corporation of America has recently placed on the market a new flue gas recorder, which makes a continuous and simultaneous record on one and the same chart of the percentages of CO_2 and of combustible gases (CO, CH_4 and H_2) in the products of combustion. It is becoming more generally recognized that the per cent. of CO_2 alone is not a sufficient guide in avoiding unnecessary combustion losses, and that combustible gases may be lost up the stack with either a high or low percentage of CO_2. Diagram Fig. 1 shows the losses taking place with different amounts of CO_2 and no combustible gases present, while the second diagram, Fig. 2, shows what the losses are before and after a certain critical point C is passed, where the most perfect combustion conditions possible are present. When this point is passed the decreased air supply causes the formation of combustible gases, even while increasing the percentage of CO_2. This point C is constantly varying. The purpose of the duplex mono, as the new instrument is called, is to make a continuous, accurate record of the amount of CO_2 present at all times, and to immediately detect and record combustible gases whenever they appear. It is claimed that the instrument is so sensitive that it will detect and record amounts as small as 1-10 of 1 per cent. of combustible gases in the products of combustion.



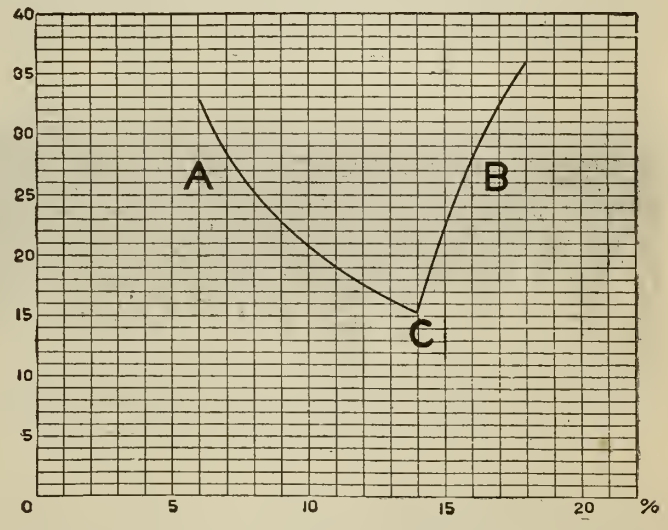


Fig. 3 represents a diagram made by one of these new double-recording instruments. The lower contour of the diagram accurately represents the percentages of CO_2 present at all times. The lighter areas in the diagram indicate the presence of combustible gases (CO, CH_4 and H_2). The proportion of combustible gases present is roughly indicated by the height of the lighter areas at any particular time.

Looking closer at this diagram it will be seen that at the point C, farthest to the left, combustible gases began to form when the per cent. of CO_2 was 10 and the amount of combustible gases formed increased rapidly, as the percentage of CO_2 increased to 11 per cent., only to vanish again when the per cent. of CO_2 was again reduced to 10 per cent. At point C to the right, combustible gases begin to form again, this time, however, when CO_2 is only 8½ per cent. This shows that between 4.30 in the morning and 3 o'clock in the afternoon changes have taken place in the furnace conditions such that while combustible gases began to form when CO_2 was 10 per cent. early in the morning they began to form when CO_2 was only 8½ per cent. in the afternoon. Should the operator keep CO_2 at 10 per cent. all day long, it is evident that serious losses might take place as in this case between 3 and 4 o'clock in the afternoon, as indicated in the right-hand part of the diagram. That is what happens when the maximum allowable CO_2 is determined for an indefinite period by a snap CO test.

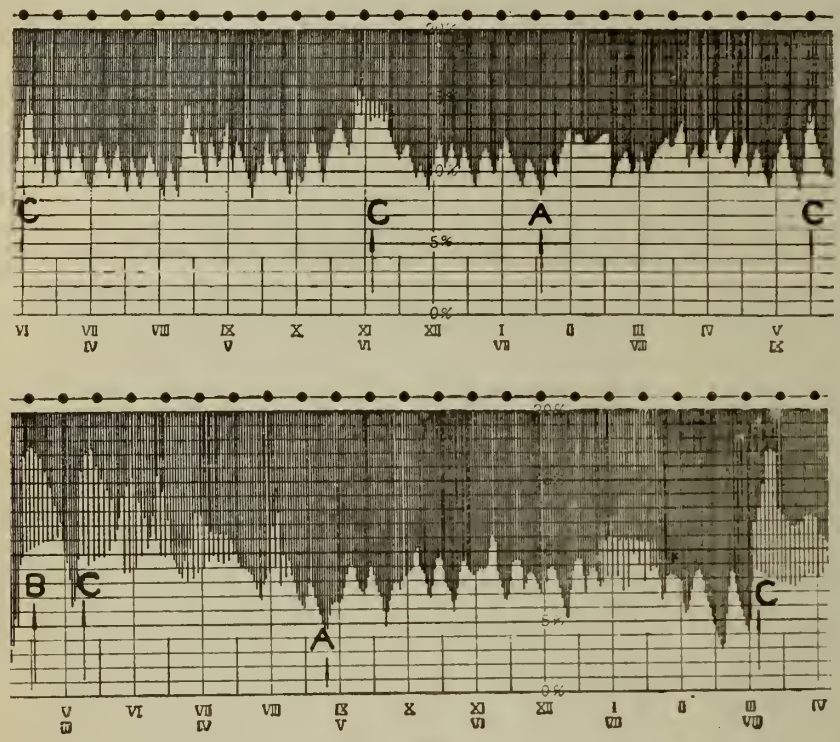
Diagram 3, which we have just discussed, shows the condition found in a boiler plant at the time the instrument was first connected, and the furnace was operated on the old principle. Certain changes were made in the furnace, the nature of the fuel and the method of firing, with the result that conditions as illustrated in diagram 4 were obtained. In this diagram it is seen that CO_2 could be carried to a point as high as 13 per cent. without the formation of CO. In other words, the critical point was raised several points higher on the diagram, the reduction in air supply without formation of combustible gases resulting in a saving of 20 per cent. in fuel. With such a record always before him the operator is always in a position to follow closely any variations in the positions of the critical point and knows immediately when combustible gases begin to escape unburned up the chimney. Where the dark contour goes below the critical point, too much air is supplied, or there is improper distribution of air. Where, on the other hand, the dark contour rises above the critical point, that is, the point where light areas begin to show, the supply of air is insufficient.

General Characteristics of the Instrument

The apparatus (see Fig. 5), is driven by water pressure of about 10 lbs. per square inch. Before entering the instrument, the gas samples from the flue are pulled through a filtering system, which removes all traces of soot and dirt. They are then drawn into and forced through the apparatus by a mercury

piston. There are no mechanical valves, such functions as these ordinarily fulfil being performed by various kinds of mercury seals, traps, etc.

Samples of gas are forced alternately through two routes; one leading directly through a caustic potash tank where CO_2 is absorbed, and the other first through an electrically heated furnace wherein the combustible gases are oxidized to CO_2 and H_2O, and then through the caustic potash tank. Samples that are forced through the caustic potash tank only give the readings for CO_2. Those that are first forced through the electrically heated furnace and then



through the caustic potash tank give readings of CO_2 plus combustible gases. The difference between any two successive readings is proportional to the amount of the combustible gases present at the time the analyses are made.

In the electrically heated furnace, the oxygen necessary to oxidize the combustible gases, CO, CH_4, and H_2 to form CO_2 (which is later absorbed in the caustic potash tank) and water (which is condensed) is usually taken from the air which is almost invariably present in flue gases, even when combustible gases are present. When such free oxygen is not available, oxygen is taken from copper oxide provided in the furnace for that purpose. The copper oxide, however, probably seldom acts as anything but a catalytic agent and need never be renewed.

Should any of the copper oxide be reduced to plain copper to oxidize combustible gases in the process of analysis, it is reoxidized by oxygen present in the flue gas samples passing through the electric furnace later.

To diminish the lag between the time when the gas leaves the flue and the analysis is recorded on the chart, small communicating tubes are used. The lag between the time that the sample is taken from the flue to the time that it is recorded by the instrument is about three minutes where the distance between the instrument and the point where the flue is tapped is about 60 feet and the instrument is making about 40 analyses per hour.

These instruments are made to produce records covering a range of either 20, 25 or 40 per cent., according to the purpose for which they are intended. The 20 per cent. range is the most common. A range shifter can be provided so that the position of the range is adjustable, that is, the 20 per cent. range, for example, can be set between 0 and 20, 5 and 25 per cent., 10 and 30 per cent., or between any other limits at the will of the operator.

The recording pen, when at its highest position, comes into contact with an ink container having a two weeks' supply of ink. The ink in the pen is automatically replenished every time it returns to the high point on the chart.

The apparatus is practically dustproof and requires only a slight amount of attention, which consists in winding the clock once a week, replacing the caustic potash solution two or three times a month, replenishing the ink supply twice a month, and putting in new rolls of paper once every two months.

Accuracy of Records and Their Value

The readings indicating the presence of combustible gases are exaggerated, if anything, by the duplex mono. This is quite an advantage in a danger signal. The losses due to the appearance of combustible gases are much greater than the savings due to an equivalent increase in CO_2 as registered on the chart, and an exaggerated record of their presence on the chart has a favorable effect on the fireman. Since it is aimed never to have combustible gases present at any time anyhow, there would be no object in having exact records of the percentage present where they do appear. An approximate, and preferably an exaggerated, record is all that is necessary, and this is the kind of record made by this instrument.

It is claimed that the CO_2 records of the machine are invariably accurate. This makes possible the accurate determination of the critical point at any time under any conditions. The critical point, C, as mentioned before, is the highest percentage of CO_2 that can be reached in a given furnace without having combustible gases begin to appear. The higher it can be raised, the more economical is the process of combustion. Knowing its maximum from the clear and accurate records of the instrument, the fireman can always tell the degree to which he is approaching ideal conditions. Should combustible gases appear at a point below the critical point, he knows that his dampers, fire doors, or the fire itself needs immediate attention, which experience soon teaches him to give to the best advantage.

The plant executive is given a permanent record which gives him the data necessary to compute the degree of efficiency attained in the firing of the furnaces, and offers him every opportunity to intelligently appreciate the efforts of the firemen. It enables him to give valuable suggestions and advice and to co-operate with the boiler room force most effectively towards promoting fuel economy.

The Meeting of Electric Generator Troubles

Some of the Common Defects of Electrical Generators, Their Cause and Remedy, are Discussed in a Practical Manner in This Article.

By F. A. SWEET

WHEN a generator fails to produce current the cause can usually be traced to the inability of a self-excited unit to build up its field. To start such a unit properly a certain amount of field residual magnetism is required, which must be increased to full strength by the current generated in the machine itself. This trouble is not likely to occur in a separately excited unit, and if it does it is usually due to the failure of the exciter.

The cause of this condition is weak or destroyed residual magnetism, due to vibration or jar, proximity of another current, a strong current through the armature, when there is little or no field current, which tends to neutralize or reverse the field owing to the reverse ampere turns, and accidentally reversed current through shunt or series fields coils which may not be enough to reverse the magnetism completely. Reversal of magnetism will not cause failure to generate. The symptom of this ailment is weak or no attraction when the pole pieces are touched with a piece of iron.

To relieve the condition, send a magnetizing current from another machine through the field coils, then start the generator again. If this fails, change the direction of the exciting current since it may have enough polarity to prevent them building up in the case. Shifting the brushes backward will make the armature magnetism assist that of the field. Change the polarity of the machine so that influence of adjacent machines will have opposite effect.

Another cause to be reckoned with is reversed connections or reversed rotation. An indication of this condition is the fact that while running the pole pieces will not attract a piece of iron. The application of external excitation will not, in this case, make the machine generate because whatever field is built up is destroyed by the armature current.

The remedy is to reverse either the field or armature connections, to move the brushes through 180 deg. for two-pole, 90 deg. for four-pole, 60 deg. for six-pole, etc., or to reverse the direction of rotation. After any of the above alterations the field will have to be excited from an outside source.

Another cause in short-circuiting of either the internal or external circuit which manifests itself in weak magnetism: If the short is in the external circuit it will prevent a shunt dynamo from building its field; but with a series machine the building up of the field will be hastened. If the short is in the machine it will likely prevent the building up of either type. A slight short such as a defective socket or copper dust on the commutator may prevent a shunt machine from building up, as will also an overload.

Field coils opposed to each other are still another cause of failure to generate. The evidence of this condition is the appearance, when tested with a compass, of similar poles adjacent to each other. This state of affairs can be corrected by reversing the connections on the reversed poles.

An open circuit which may be caused by a broken wire or faulty connection in machine, brushes not in contact, safety fuse being blown or circuit breaker being out, or an open switch, will naturally cause failure to generate.

If the trouble is an external open circuit the field of a shunt machine will be fully magnetized and the machine will be working perfectly; but if the trouble is inside the machine, the fields will be weak. A break in the field circuit of a separately excited installation will prevent generation and is indicated by no field in the generator and full exciter field.

A break in a single-phase series-wound armature will result in non-generation, in a two or three-phase "Y" armature will cause it to generate single-phase, while in a delta armature it continues to give three-phase, but at reduced capacity.

To remedy, make a careful inspection for open circuit in both field coils and armature. A break or excessive resistance in the shunt field or field regulator will also make the magnetism weak. This may be detected by cutting out the rheostat for an instant or by connecting the two terminals of the field coils to the brushes in first one and then the other direction.

A high resistance in the circuit of a series-wound machine will prevent building up. Short the machine momentarily to start the field.

Failure to generate may also be caused by the brushes being improperly placed. The tell-tale of this condition is a change in the magnetism and voltage when the brushes are shifted.

It frequently happens that the brushes are not set at the correct point or they may be set at exactly the wrong position, in which case the machine is incapable of delivering any current whatever. This trouble is probably due to the fact that no two machines have the same setting. Drawings should be obtained showing the proper position of the brushes before an attempt is made to set them.

Sparking at the commutator is a common trouble. One cause of this is excessive armature current, due to an overload on the machine, short circuit, ground or excessively high voltage.

To remedy, reduce the load, eliminate the short circuit or ground, or reduce the voltage.

Brushes not set at the neutral point may cause excessive sparking. In this case the sparking will vary when the brushes are shifted. The brushes should be shifted until the trouble disappears. Care should be taken to see that the brushes are exactly opposite.

A commutator rough, eccentric or with high bars will cause sparking, due to imperfect contact of the brushes. A rough commutator should be filed or stoned down, or even taken out and turned if extremely bad. Eccentricity may be in the armature or merely due to a loose bearing. If the former, it should be turned down; if the latter, new bearings should be fitted.

In order that the commutator should wear smooth the shaft should be allowed end play of about ⅛ inch.

Other causes of poor conductivity at the brushes are dirty or oily brushes, a glass hard brush which is incapable of wearing to a good seat, or a brush that has a high specific resistance.

The remedy is to clear the fouled parts and replace poor brushes.

A short-circuited or reversed coil in the armature will cause sparking, which condition can be noticed by the excessive power required to run the generator without load. The short-circuited coil heats faster than the others and is likely to burn out unless promptly attended to. A piece of steel held between the pole pieces near the armature will vibrate as the defective coil passes.

Such a short is often caused by a piece of solder or other metal getting in between the commutator bars or their connections. The trouble is easily found and remedied. If, however, the short is in the coil itself the only reliable repair is to rewind the coil.

A broken armature circuit will cause violent flashing and the bar nearest the break will be badly burned. A poor contact somewhere in the circuit will have this same effect to a lesser degree.

Such a break or poor contact may be located by the drop of potential or continuity test. The break is usually in the connections between the coil and bar, where it can be readily repaired. If it

is in the coil the only remedy is to rewind the troublesome part.

A ground in the armature will often cause sparking. When two or more grounds occur in the armature the result is a short circuit and the case should be so treated. A single ground on electric railway line or a three-wire system with the neutral wire grounded will have the same effect.

To find the ground wrap a flexible conductor around the commutator. Apply a current through this connection and the shaft. If a ground is present a current will flow and the defective coil will be energized. It can then be located with a compass.

A weak magnetic field causes sparking. The tell-tale of this condition is weak pole pieces and the point of least sparking is shifted considerably from the normal position. Full voltage or current is not forthcoming.

The causes of this condition are (1) a broken circuit, which may be found by opening the field circuit after having insulated the field; if no spark occurs there is a break some place in the circuit; (2) short-circuit; (3) grounding, which may be found by drop-in-potential method.

A broken circuit is easily repaired if accessible; if it is in the coil the coil will have to be rewound. If the circuit voltage is low, sparking will result. If it cannot be raised the field resistance should be reduced by unwinding a few layers of wire.

Flashing over is a spark jumping from one set of brush holders to another or to the frame. This is caused by poor or insufficient insulation between the points mentioned or by deposits of copper or carbon dust on the surface of the insulation. This latter is the usual cause and the trouble can be eliminated by simply cleaning the parts with an oily cloth.

Ring fire is an exaggerated case of commutator sparking and may cause flashing from one set of brushes to the next. The remedies for commutator sparking will obviously do away with this trouble.

Any of the causes of sparking will cause heating of the commutator. In fact, heating frequently occurs from these causes before sparking is noticeable.

The next in importance is heat spreading from other parts of the machine. The machine should be started when cool and run for a few minutes, then a search made for warm parts before the heat has a chance to radiate to the rest of the machine.

These parts should be attended to as directed under their respective headings.

An overheated commutator will cause deterioration of the brushes and cover it with a black film, which offers more resistance and aggravates the trouble. The commutator should be cleaned and the different brushes fitted if necessary.

Brush connections may offer abnormally high resistance, which may be tested by the drop of potential method and improved.

Heating will occur when there is an arc or short circuit between bars or between bars and end ring. The arc will be noticeable when the machine is runing. Burnt or otherwise defective insulation should be taken out and replaced.

Brushes of high specific resistance will produce heat. Better carbons or greater conductivity should be installed.

The friction of the brushes will also produce heat. This case can be differentiated from the preceding one by noting whether or not the temperature is excessive when the current is light. This may be due to heavy pressure or high speed. Reduce the spring tension. Decrease speed, but keep up the voltage by increasing the field. Lubricate slightly with oil or vaseline.

Excessive current will cause heating of the armature as will also moisture in the coils. Moisture can be detected by steaming when hot. The armature should be taken out and baked for several hours at a temperature sufficiently high to drive out the moisture, but not hot enough to injure the insulation.

When the iron of the armature core is found to be warmer than the coils after a short run and when considerable power is required to turn the armature when there is no current through it and when the field is connected, indications are that there are eddy currents in the core. There is a question of poor lamination and a matter of primary construction.

Reversed coils in one part of an armature will cause local currents to circulate around a direct-current armature, causing a rise in temperature. This will mean excessive power to drive a generator without load. A compass will indicate the reversed coil when a current is sent through each coil separately. The remedy lies in simply reconnecting the terminals to agree with the rest.

Excessive current in the field circuit will bring about heating of the field magnets. A temperature of 122 deg. F. above room, as determined by a resistance test, is considered high.

In the case of a shunt wound or separately excited machine, decrease the field voltage or increase the resistance. In the case of series winding, shunt a portion of the current. This condition might be cause by a short circuit, in which case the defective coil will be cooler than the others. As a check measure the resistance of each coil; if there is any considerable variation the low resistance coil is sure to be grounded or short-circuited.

In alternating or pulsating current work the field pieces will become heated, due to eddy currents unless they are carefully laminated.

Moisture in these coils will cause short-circuiting and heating, as in the armature.

Heating of bearings is a condition to which any machine not properly constructed or attended to is subject. In cases where a stop for repairs would be fatal, temporary relief may be had by pouring cold water on the bearing or packing it in ice.

This state of affairs is usually due to lack of oil. The oil passages may be clogged, the reservoir dry, the oiling devices out of order. These defects should, of course, be remedied. Use good oil. It will be money well invested.

Grit in the bearings will cause heating. Remove the bearing and investigate for foreign particles. Scratches will be noticed. Remove the dirt, clean the bearing, use clean oil and provide a dirt-proof casing if necessary.

A shaft that is rough, scored, or too large will also cause heating. It should be turned down in a lathe and refitted.

A sprung shaft presents difficulties in truing and a new one is usually necessary.

A shaft turns hard and heats when the bearings are out of line. Conditions are relieved by loosening the holding bolts. Bolt the bearings in a position where the shaft turns freely, being sure that the armature is in the center of the field.

Thrust of a shoulder or the shaft against the bearings will generate heat and is caused by the belt drive being out of line or by the armature not being centered axially with the field coils. The remedy will be found in lining up the belt or moving the collar to allow the shaft to center itself.

Too heavy tension on the belt or eccentricity of the armature will cause an extra load on one side of the bearing and heating of the bearing which will wear elliptical in time and aggravate the trouble due to an eccentric armature. The belt tension should be decreased, using a larger pulley if necessary, and the armature should be centered. If the bearings have worn elliptical, new ones should be fitted.

The most frequent source of noise is the humming, squeaking or hissing of the brushes on the commutator. This trouble can readily be located by the ear. File or dress the brushes down with sandpaper and apply a little oil or vaseline. Changing the length of the brushes and the pressure often helps.

Vibration due to the revolving armature, field, pulley or commutator being out of balance is, of course, objectionable. The parts should be taken out and balanced, separately, because a static balance of the whole combination is not likely to prove to be a dynamic one. A dynamic balance takes place only when equal moments are directly opposed to each other.

When the armature rubs against the pole pieces, noise results. Bind down any abnormal projection on the armature; center the armature; chip off high spots on the field pieces.

Noise caused by the collar or pulley rubbing on the bearing is due to the

Continued on page 36

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OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

CLEANING A BOILER

Question.—Would you recommend the use of sal soda to remove soft scale from a boiler. Should it be fed through feed water and if so how much?

Answer.—Sal soda is generally a very safe and economical material to use for the purpose of softening scale and keeping boiler clean. The quantity that should be used will depend entirely on the amount of water that is being evaporated daily, as on this depends the amount of solid matter that will be deposited in the boiler. If your boiler is 60 H.P. and you are running ten hours a day, about one pound of sal soda per day should be ample. However, you would have to determine the necessary quantity by experiment unless you know the exact analysis of the water. With soft scale such as you mention, it is well to be careful about using too much soda, as when your boiler is banked at night and circulation is practically stopped, the sediment is very liable to deposit in one spot, causing a burnt plate. In operating a locomotive boiler such as you mention it is well at first to open it up frequently and determine the condition, from which you can judge as to whether you are using enough soda or otherwise.

To remove the scale before starting up, fill the boiler with clean water and add about ten pounds of sal soda. Leave the manhole door off and heat boiler up gently till water boils. Keep a very light fire, just enough to keep the water simmering for two or three hours. Then let the fire die down and let the boiler stand for a couple of hours more. Then open the blow down cock and let the water drain out, and if possible have a hose and follow the water down with the hose. That is, as the plates, etc., become bare, wash them off with the fresh water from the hose. This prevents any sediment sticking to the warm plates as the water subsides. In this manner you can get even a very dirty boiler clean, and should have no trouble with a boiler such as you mention.

When running and using the soda daily, do not use the blow down cock too much. It is well to blow a little water out to keep the blow off outlet clear, and to remove any sediment that may accumulate in the bottom of the boiler. However, dont forget that all the water you blow out has to be replaced with water that also contains sediment, so that you may easily be adding more sediment than you blow out.

A SHIFTED ECCENTRIC

Question.—In a marine engine, if your go-ahead eccentric sheave slipped on the shaft when under way, what would be the quickest way to adjust it? What would cause a clattering noise in the cylinder of a vertical ammonia compressor?

Answer.—A simple way of adjusting the strap would be to place crank on top or bottom center and open drain cock on cylinder either at top or bottom, whichever end crank is at. Turn eccentric sheave around with link in ahead position, until the spindle has travelled to the end of its stroke and starts coming down again. Crack main stop valve so that a wisp of steam can leak through and turn eccentric round till steam shows through the drain cock. The valve is then open to steam and eccentric is in nearly the correct position. Another way is simply to turn sheave around until it is as nearly as you can judge at 120 degrees ahead of the crank, and try your engine at that. The first method is in the long run the quickest. If you have a turning gear fitted ship it before starting to set your sheave. If there is no turning gear block the crank so that it can't turn.

* * *

PUMP NAME PLATES

Question.—On all pumps air compressors, etc., the maker puts a plate with the dimensions, length of stroke, etc. Is there any hard and fast rule for reading these. If so in what order?

Answer.—It is usual to put first the size of steam cylinder, then the size of water cylinder, and lastly the stroke. For instance, on a boiler feed pump the plate might read 2x1½x2¾ in., which would mean a steam cylinder of 2 in., a water cylinder of 1½ in. and a stroke of 2¾ in. If the steam part of the pump is a compound arrangement, the cylinder sizes will be given with the high pressure first, then the low, followed by the water end cylinder sizes, and lastly the stroke. The same rule applies to air compressors, the first sizes given being the steam end, then the air end, and lastly the stroke.

* * *

BOILER HORSE POWER

Question.—A plant having four water tube boilers said to be 360 B.H.P. each, two of them only are working at one time and two are dead, for repairs, cleaning, etc., never any more than two in operation. What is the B.H.P. capacity of plant? I have been told that it is 1,440 B.H.P. Is that right?

Answer.—The B.H.P. capacity of the plant is the total rated capacity of all the boilers in the plant. You have four boilers of 360 H.P. each; then the plant is 1,440 H. P. The fact that you do not avail yourself of the total capacity does not decrease that capacity.

GENERATOR TROUBLES

Continued from page 34

same condition that causes bearings to heat, and should be so treated.

Rattling due to the looseness of parts can be eliminated by careful inspection of the machine before or after each run. Tighten up the loose parts. Replace a poorly fitting bearing.

The flapping of a belt joint on the pulley produces a disagreeable sound which should be stopped by making a better joint.

An intermittent squeaking sound which indicates a slipping belt may be overcome by increasing the tension of the belt or by applying a belt dressing.

The humming of the armature core teeth as they pass the pole pieces ought not to occur if the machine is properly constructed. It can be relieved by sloping the edges of the pole pieces.

Humming due to alternating current is inherent to a large extent in alternators, but can be deadened by mounting the machines on felt or some such material.

Improper voltage is a common difficulty which may arise in any machine, and is due to the following causes: Field magnetism too strong or too weak; brushes not in proper position; generator overloaded; short-circuited or reversed armature coils.

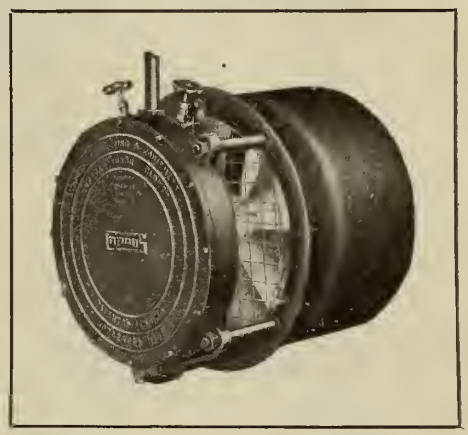
All of these produce sparking and are dealt with under that head.

Speed too high or too low, or open, short-circuited or reversed field coils may prevent a dynamo from generating current.

A direct or alternating-current generator, unless it is compound or composite would tend to fall in voltage with increased load. This is usually overcome by raising the field current or by cutting out field resistance.

COPPUS TURBO BLOWERS

In Use in Large Canadian Steam Plants



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Boilers are consistently operated at high over-rating where Coppus Turbo Blowers are installed. More steam is produced, greater efficiency, greater returns from capital invested in boiler room equipment. Fuel troubles never bother where Coppus Turbo Blowers are at work. The worst coal is burned under boilers with almost perfect combustion and thorough efficiency.

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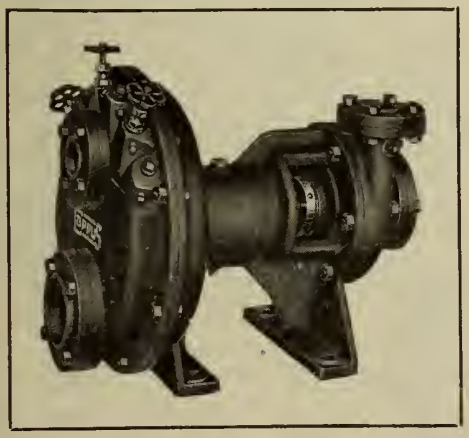

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1¼-in.	29 50	.....
1½-in.	31 50	29 50
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3¼-in.	.....	48 50
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Plates, 3/16-in.	$6 50	$6 00
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Price List No. 38

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¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
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2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
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Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
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10L	2.77	3.41	3.41	4.05
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Royalite Oil, per gal., bulk	29½
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Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 50
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
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Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
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Soldering coppers, lb.	62½
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Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
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Standard	14	Keen	11
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Arrow	35	Anvil	22
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Select white	20	Dark colored	09
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Drilling cables, Manila	0 39
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Packing, square, braided	0 38
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New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

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	Gross Mont.	Toronto
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Lead	7 75	9 00
Antimony	8 25	9 00
Aluminum	35 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Are You Troubled With Production Losses Due to Faulty Valves?

Mason Regulating Appliances

Will Stop All Leaks

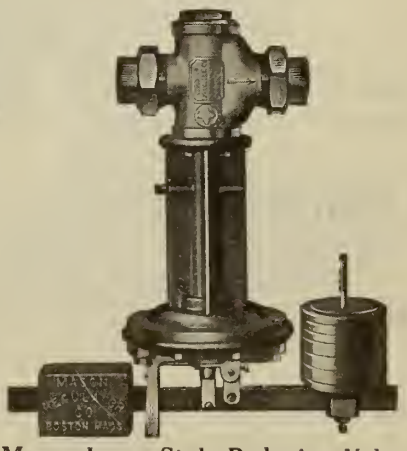
THERE is no reason to go on wasting steam and money by using inefficient valves. Get in touch with a Mason engineer. He will show you the economical way of installing Mason positive acting appliances. He will explain the substantial saving this will net you.

Mason appliances are to-day the choice of thousands of Power Users. In the most critical positions—where absolutely even pressure is demanded—Valves and Regulators of Mason design are fulfilling their purpose with steadfast reliability and a minimum of attention.

Mason Standard Reducing Valve Iron Body

Mason Standard Bronze Reducing Valve

If you are concerned with results we heartily welcome your enquiries. We handle Valves and Regulators for every purpose, and our Engineers are always ready to offer assistance.



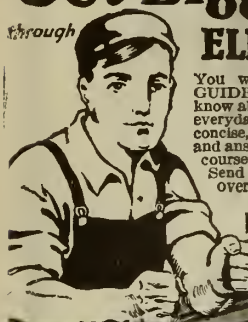
Mason Lever Style Reducing Valve

The Mason Regulator & Engineering Co., Limited

Montreal Office and Factory: 135-153 Dagenais St.

OFFICE—145 WELLINGTON ST. WEST (Room 5)

Get Bigger Pay through ELECTRICITY



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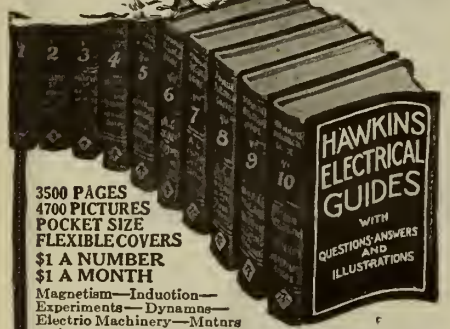

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SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

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Employed by_____

Residence_____

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Regarding

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A REQUEST FOR CHANGE OF ADDRESS must reach us at least thirty days before the date of the issue with which it is to take effect. Duplicate copies cannot be sent to replace those undelivered through failure to send this advance notice. Be sure to give your old address as well as the new one.

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

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ENGINEER QUALIFIED TO TAKE CHARGE of Saw Mill Power Plant; only competent man need apply; duties to commence immediately. Apply Box 24121, "Power House." P.F.H.

WANTED—A1 GENERAL BLACKSMITH FAMiliar with mine and mill work; permanent position. Apply, mentioning "Power House," stating experience and wages wanted, to Moose Mountain, Ltd., Sellwood, Ont. (pfh)

EQUIPMENT

THE JOHN INGLIS CO., LTD., ENGINEERS and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention "Power House."

WE BUY IDLE EQUIPMENT OR MACHINery; call or write. Apply, mentioning "Power House," to H. W. Petrie, Ltd., Toronto.

OIL ENGINE — BLACKSTONE. 8½ IN. diameter, 16 in. stroke, 16½ brake horsepower; fly wheels, 5¾ in. face x 4 ft. 10 in. diameter; in complete operating condition. Apply, mentioning "Power House," to Henry Engineering Co., 71 Bay St., Adelaide 3466. P.F.H.

WANTED — MOTORS AND ELECTRICAL equipment. Apply, mentioning "Power House," to Industrial Engineering Co., 28 Wellington West, Toronto. Phone Adelaide 5817.

PORTABLE BOILERS—LOCOMOTIVE TYPE on wheels; each 15 horse-power with engines mounted on boilers; can get Government certificates for 90 and 100 pounds working pressure; cheap; also 40 horse-power high speed Leonard automatic engines. Apply, mentioning "Power House," to Henry Engineering Co., 71 Bay St., Toronto. Adelaide 3466.

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4½—4-PLY NEW CANVAS STITCHED BELTing at 30 cents per foot. We carry a complete stock of belting, pulleys and mill supplies. Apply, mentioning "Power House," to N. Smith, 138 York St., Toronto.

LEATHER AND RUBBER BELTING, USED, but in good condition; at about half new price. Apply, mentioning "Power House," to Tarshis & Sons, 400 Front St. East, Toronto.

WE HAVE A QUANTITY OF NEW RUBBER belting to sell at less than half price; will ship C.O.D., subject to inspection; new circular saws, good second-hand leather and rubber belting, wire cable, vises, chain blocks, garden hose, steam hose, rubber packing; send us your requirements; our quotations will surprise. Apply, mentioning "Power House," to The York Belting Co., 115 York St., Toronto, Ont.

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ALL STYLES TO ORDER—PROMPT DELIVery. The E. T. Lansdowne Foundry Co., 37 Niagara St., Toronto. Mention "Power House."

LOOK AT THE ADDRESS ON YOUR LABEL

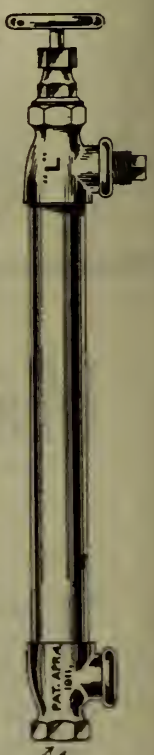
IS IT CORRECT ?

If wrong, tear it off and return to us with correct address plainly written.

Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap



Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admission of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds. Being open at starting, it cannot become air bound, this doing away with air cocks or vents — Does Not Freeze.

It is capable of draining from 900 to 1,500 feet of one inch pipe.

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to

J. T. LONG
84 Adams St.
MONTREAL, C

If your dealer does not sell it, write direct. No. 2

NON-CORROSIVE CYLINDER OIL

MANUFACTURED ONLY BY E. H. KELLOGG & CO. NOS. 24 & 224 SOUTH ST. NEW YORK, U.S.A.

FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

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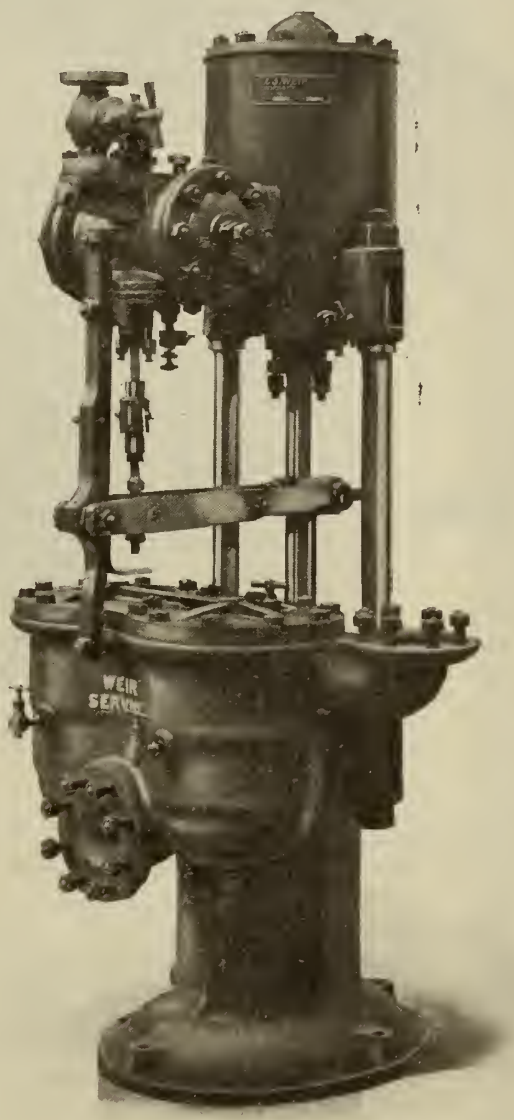
Single Acting Simplex Feed Pumps
Turbine Rotary Feed Pumps
Compound Feed Pumps
General Service Pumps
Direct Contact Heaters
Multiflow Heaters.
Evaporators and Distillers.



Built to Absolute Standards

EACH part of every Weir power plant auxiliary is built to an absolute standard. This guarantees uniform results from all products and also enables repairs to be made with as little delay as possible.

The value of facilities for making quick repairs can hardly be over-emphasized. Consider these features of Weir Products when purchasing power plant auxiliaries.

Special attention is paid to the prompt dispatch of goods and the routing and shipment of all consignments. Special instructions in this regard always receive our most careful attention.

Prompt and careful shipment is but a single phase of Weir Service. To serve our customers in every way to the best of our ability is our aim.

G. & J. WEIR (CANADA) LIMITED

Sales Engineers

PEACOCK BROTHERS, LIMITED, MONTREAL

DEVIL'S PUTTY

The Way to Greater Coal Economy

Recent discoveries have led to the production of a jointless fire brick which can be molded into the furnace and then baked into a solid lining. The advantages are obvious. No heat can escape—no joints to start disintegration—no cracks to hold clinkers.

PLIBRICO
JOINTLESS

FURNACE LINING

forms one massive heat-resisting setting which expands uniformly, preventing cracks and breaks. It remains heat-tight under modern high temperatures up to 3100 degrees F.

Plibrico has been thoroughly tried out. We can send you convincing endorsements from some of the largest firms in the country, if you are interested.

Shipped promptly in large steel containers from our nearest warehouse in all principal cities.

Plibrico is used in every case where laid up fire brick is used and with better results. Try it on a front door arch or wall and the saving effected will demonstrate the greater value of a complete Plibrico setting.

Send for our booklet on furnace building.

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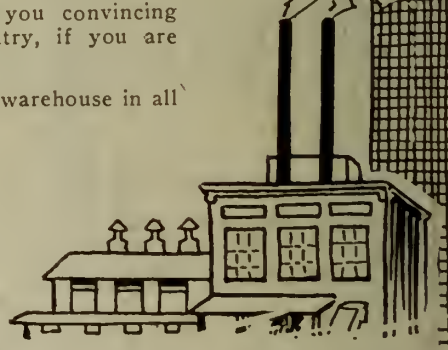

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FIRE BRICK CO.
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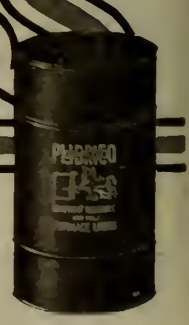

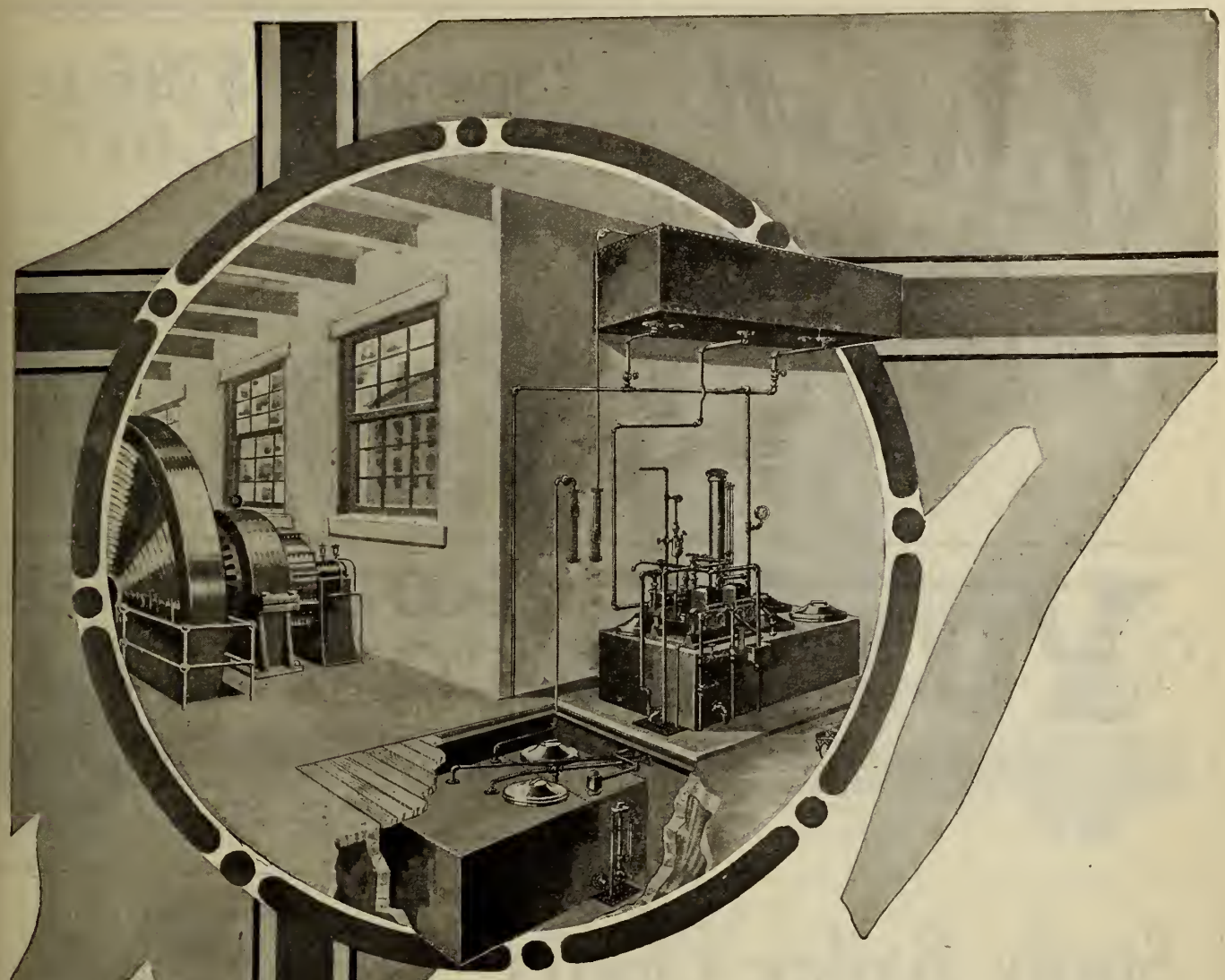

Save Fuel by Reducing Friction

Much of the friction on engines is due to irregular hand feed lubrication or using oil which is dirty and contains impurities. This increased friction necessitates the consumption of more coal to produce the required power.

Reduce this friction by installing a Bowser Stream Feed Circulating and Filtering System.

A close study of operating costs in power plants has proved conclusively that there is a reduction in friction and a saving of approximately 5 per cent. in the fuel costs where stream feed lubrication is in practice as compared with hand lubrication methods.

In a plant of only ordinary size, a year's saving in the reduced friction will pay for the installation of a Bowser Stream Feed Lubricating and Filtering System.

Write for our illustrative booklet showing our various filtration systems.

S. F. BOWSER COMPANY, LIMITED

TORONTO, CANADA

Branch Offices in Principal Cities of U.S.

Vulcan Performances

"Spending $796 to earn $1017.40!"

ALMOST any business manager will agree to an expenditure of $796 provided he can be shown some assurance that it will return $1017.40 per year.

Improbable as such a return may sound on its face, it is nevertheless a fact that can be demonstrated, that Vulcan Soot Cleaners will pay more than 100 percent on their investment, depending upon boiler size, cost of fuel, conditions of operating service, and that intangible thing—human nature.

"SPENDING $796 TO EARN $1017.40!" is the title of a folder just issued, explaining mathematically how Vulcan Soot Cleaners pay their way—and a profit, besides.

Send for your copy.

Vulcan Soot Cleaners are built for every type of water tube and fire tube boiler, superheaters and economizers. For estimate of cost for installation in your boilers, state name of boiler, number of tubes high and wide, boiler pressure available, if equipped with superheater, and alley space at sides. Special Bulletins describing Vulcans for various types of boilers will be sent gladly upon request.

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS PA OFFICES IN THIRTY CITIES

WINNIPEG
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TORONTO
Green's Economiser, Ltd.,
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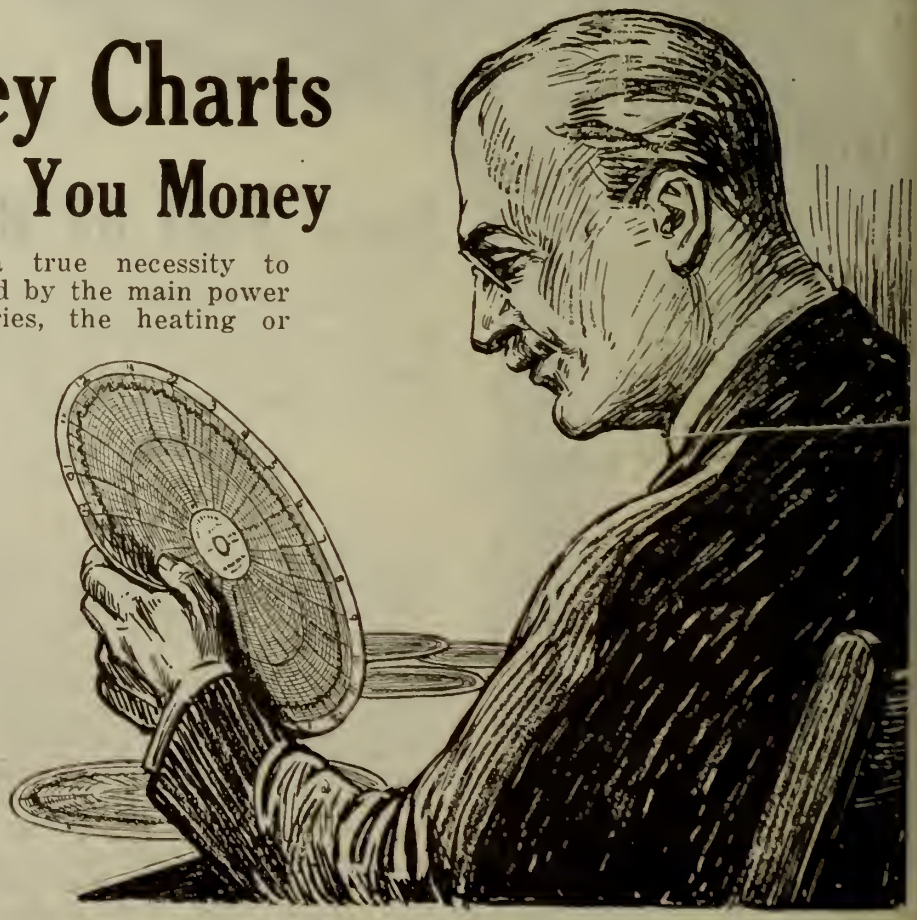
Study Bailey Charts
They Will Save You Money

Bailey Fluid Meters are a true necessity to determine the steam consumed by the main power generating units, the auxiliaries, the heating or drying system, special process work, by the various factory departments and outside purchasers of steam.

They accurately indicate, record and integrate steam flow on all pressures and temperatures without constant recalibration or repairs.

Study Bailey Charts. The elimination of even slightly abnormal operating conditions may mean the saving of many dollars in coal and labor.

Write for bulletins.



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19 Jarvis Street, Toronto, Ont.

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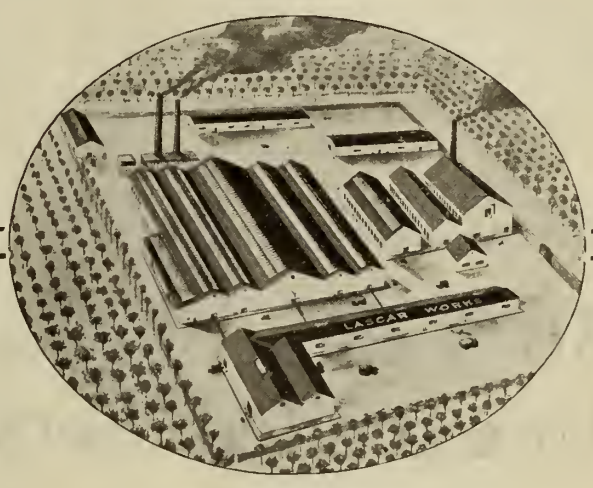

LASCAR WORKS:
HOUNSLOW, MIDDLESEX, ENGLAND
Manufacturers of the well known
LASCAR AND ALLIED BRANDS
of Asbestos Goods

Prompt Service in Supplying the Well-Known Brands of

PACKINGS

LASCAR V, for high pressure.
HINDOO STEAM, for high pressure.
EXPANDO, Cushion Packing.
BELDAMOK, for Superheated Steam.
PANDO V., for Hydraulics.
GHURKA, (Hollow Core), Hydraulic.
KYMBALA, High Pressure Jointing (Blue).
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ALLIED Brands, Asbestos Sheeting, Jointings, Gaskets, Tape, also Pipe and Boiler coverings
LASCAR Brands, Rubber Sheeting, Valves, Hose and Beltings.

Distributors Carrying Full Stocks

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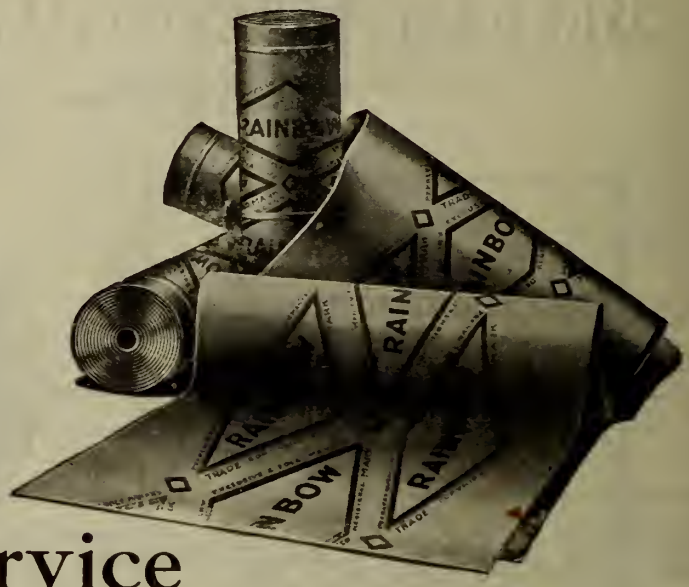
These Packings are used extensively and with most satisfactory results by His Majesty's Admiralty and leading Steamship and Engineering Companies.

SERVICE Large stocks are carried, thereby assuring prompt delivery.

IF IT IS MADE OF ASBESTOS WE CAN SUPPLY IT



30 Years of Unexcelled Service

—under the most exacting conditions—have proved the worth of Rainbow Sheet Packing wherever steam is used. It is the ***Original Red Sheet*** packing and the "Rainbow" trade mark is your assurance of dependability.

Rainbow Sheet Packing

is the one gasket material that may be depended upon to give faithful service and save many replacements.

We will gladly send you a Catalogue and, if you wish, one of our technical experts will help you select the right packing for your particular requirements.

Genuine Rainbow Sheet Packing is made in Canada

Dominion Rubber System

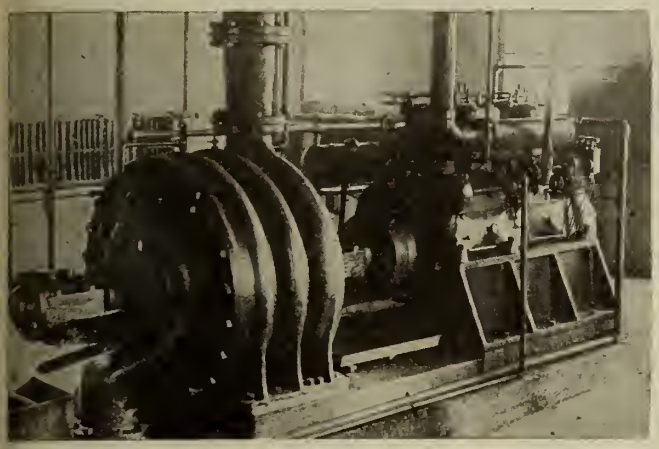
Rainbow Rubber Products Department

201 Inspector Street Montreal

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

A HIGH DUTY GASOLINE ENGINE

costs one-tenth of a steam reserve power plant, is ready *instantly* to assume full duty and consumes no fuel while standing by.



Interior pump house, Berthierville, Que., showing Model FC 4-cylinder, 100 H.P. Sterling gasoline engine employed as stand-by power for pumping emergency. These engines furnish high power for any break-down emergency.

Catalog on request

STERLING ENGINE COMPANY
Dept. C-4 BUFFALO, N.Y.

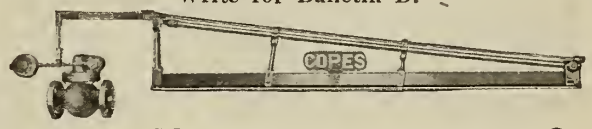
4, 6, and 8-cylinder, 12 to 300 H.P., speeds of 400 to 1500 r.p.m. for centrifugal fire pump and electric generator drives.

IS BOILER FEED REGULATION IN YOUR PLANT DIFFICULT?

Before a
Copes Boiler Feed Regulator

is installed, a careful study is made of the plant and its operating conditions. While the construction of the Copes is extremely simple, the essential parts are capable of many fine variations. These have been developed to meet every conceivable condition in boiler feed water regulation. No matter how difficult your problem, we can provide a Copes that will handle it without fail.

Write for Bulletin D.



Northern Equipment Co.
The World's Largest Manufacturers of Boiler Feed Regulators
112 West 11th Street
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H. N. BROWN
P.O. Box 620, New Glasgow, N.S.
C. C. MOORE & COMPANY, Engineers
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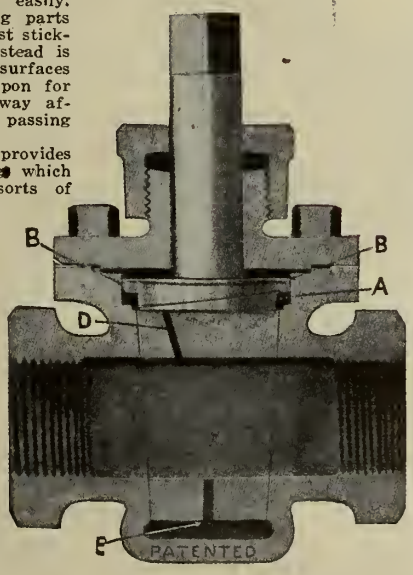
Canadian Factory, 191 Barton St., Hamilton, Ont. 99

"Homestead" Quarter Turn Valves

Embody Every Detail of Efficiency and Economy

They open and close easily. The patented balancing parts insure this valve against sticking. When the Homestead is fully opened the two surfaces which are depended upon for tightness are in no way affected by the material passing through.

The "Homestead" provides a straight-way opening which is desirable in all sorts of work, but is particularly important in high-pressure service. It is very useful when thick, heavy liquids are handled.



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Homestead Valve Manufacturing Co.
PITTSBURGH, PA.
Works: Homestead, Pa.

REG. U.S. PAT. OFF. Tycos ROCHESTER N.Y.

Tycos
Temperature Instruments
INDICATING RECORDING CONTROLLING

stand supreme as aids in temperature needs not only in the power plant, but everywhere in industrial processes that temperature is a factor.

Angle and Straight Steam Thermometers
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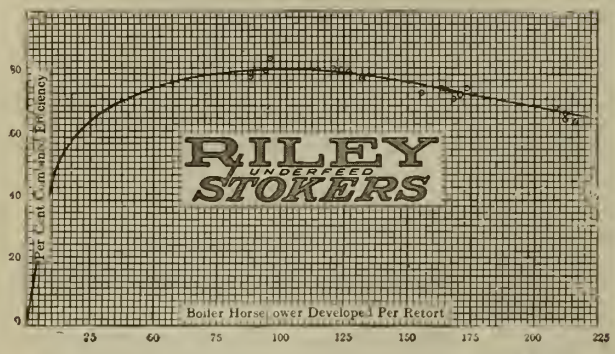
Pyrometers
Hydrometers
Barometers
Hygrometers
Temperature and Pressure Regulators
Vacuum, Pressure and U Gauges

Catalogs on request. Specify your requirements when writing that we may explain thoroughly how Tycos Instruments can meet them.

726

Taylor Instrument Companies
ROCHESTER N.Y.
There's a *Tycos* or *Taylor* Thermometer for Every Purpose

ARE YOU WASTING COAL?



If your boilers are operating at 65% efficiency, whereas you ought to be getting 75% or 80%, then you should investigate to-day the possibilities of RILEY UNDERFEED STOKERS.

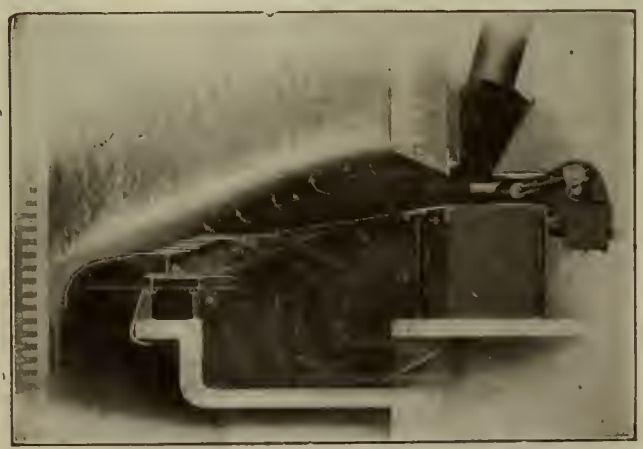
The first year after installing Riley Stokers' the Haverhill Boxboard Company saved ten tons of coal a day, and reduced their operating force by thirty-six men—a total saving of $52,000.00.

Our catalog shows a cut of an evaporation curve. From it you can figure just what you can actually save in dollars and cents by increasing your efficiency.

Catalog HR-2 sent on request.

For information on Murphy Automatic Furnaces for small boilers, see Sept. 20 advertisement, or send for Murphy Furnace Catalog HM-2.

Sanford Riley Stoker Co.
Worcester, Mass.



YARWAY PRODUCTS

are being used in thousands of plants. They are sold under a money-back guarantee.

The Scranton Coal Co. has installed twelve YARWAY BOILER SKIMMERS, four of which are shown on the right. Their Dickson City (Pa.) colliery appears above.

Speaking of RESULTS

The Scranton Coal Co., in a letter from its division superintendent, says: "Since the installation of the YARWAY SKIMMERS a little over a year ago, we have had no further trouble with scale formation, either on shells or tubes. No trouble to wash out boilers now as we find them clean, with no trace of scale. Requires only about one-third of the time and labor compared with our trouble when using compounds. Cannot speak too highly of the results we are getting from the Skimmers."

YARWAY

BOILER SKIMMER

(A continuous, circulating surface-blow)

Removes scale-forming impurities and foreign matter from boiler feed-water before they can settle on shell and tubes, except in unusual cases where certain mineral salts are carried in solution. If you will advise us of your water conditions and the type of your boiler, we will tell you frankly whether or not you can use a YARWAY BOILER SKIMMER to advantage.

YARNALL-WARING CO.

7604-20 Queen St. CHESTNUT HILL
PHILADELPHIA
Offices in all principal cities

Bulletin S-1201-A is an interesting little booklet on water-conditioning treatments. We shall be glad to send a copy at your request.

For complete list of offices see Sweet's Engineering Catalog, Condensed Catalogs of A.S.M.E., Sterling Marine Catalog, Keystone Mining Catalog, or Chemical Catalog.

No Matter What Stoker

The

Jeffrey

Single Roll Crusher

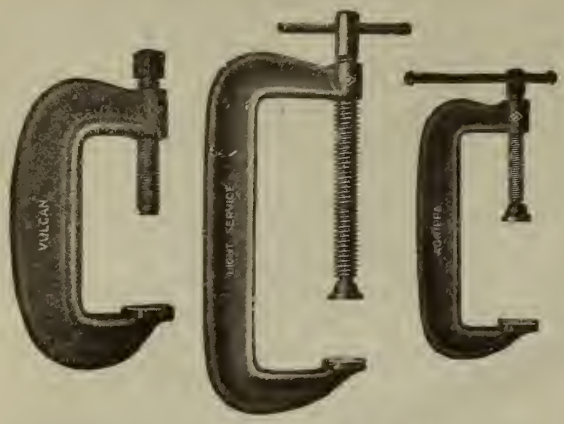
Reduces Run of Mine or Lump Coal to Stoker Size in a Single Operation.

SHIPMENT FROM STOCK

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms
MONTREAL

Patented



Williams' Superior Drop-Forged "C" Clamps

"THEY STAND THE STRAIN"

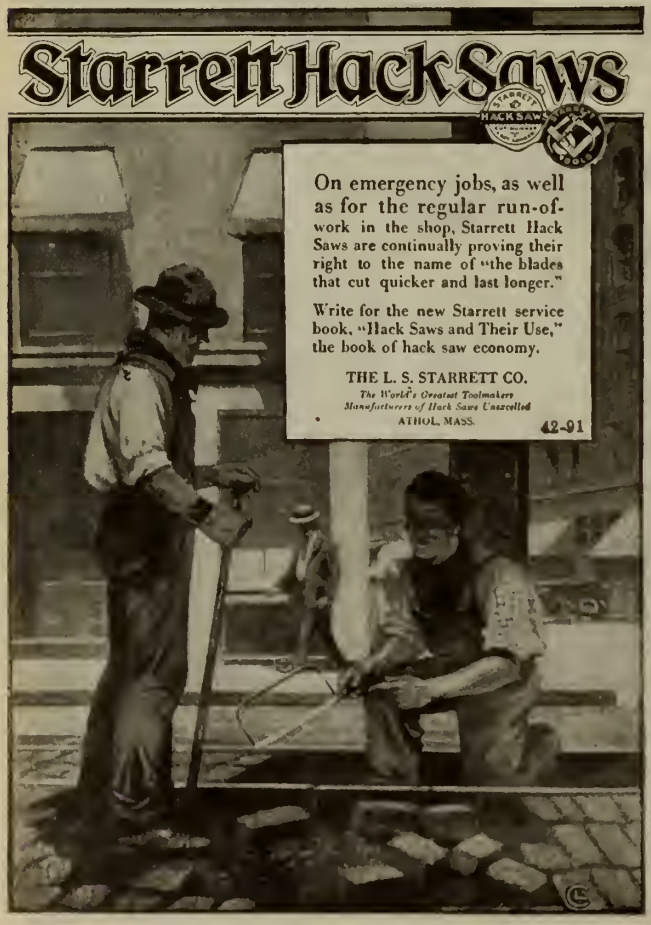
SELECT the clamp best adapted to your needs—"There's a Williams' Clamp for every purpose."
Williams' "Vulcan"—for Heavy Service—11 sizes. ¾ to 12½ inches.
Williams' "Agrippa"—for Medium Service—7 sizes. 4 to 18 inches.
Williams' "Light Service"—8 sizes, 2 to 12 inches.
Machinists' Tools Booklet on Request.

J. H. WILLIAMS & CO.
LIMITED
"The Drop-Forging People"
Formerly Canadian Division of The Whitman & Barnes Mfg. Co
78 Thorold Road, St. Catharines, Ont.

"AM BEST" flexible Metallic Packing comes in **Loose Rope Form** of long strands of Non-Friction Metal. Easily separated to suit any size rod or box. The smallest valve stem to largest stuffing box can be packed from the same can.

Mill Supply Department
BEVERIDGE PAPER CO.
Limited
MONTREAL

Starrett Hack Saws



On emergency jobs, as well as for the regular run-of-work in the shop, Starrett Hack Saws are continually proving their right to the name of "the blades that cut quicker and last longer."

Write for the new Starrett service book, "Hack Saws and Their Use," the book of hack saw economy.

THE L. S. STARRETT CO.
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS. 42-91

So rigid is the inspection through which every Pratt & Cady Valve must pass, that defects which might be overlooked in other makes are considered sufficient cause for rejection.

We look upon every Pratt & Cady Valve as a technical masterpiece, and as such we are not willing that a single valve shall go forth with a questionable flaw. We take no chances, be they ever so slight, of damaging our reputation, which we have guarded jealously for half a century as "makers of valves that give long and satisfactory service."

Catalog on request.

PRATT & CADY CO., Inc.
Manufacturers of Valves and Asbestos Packed Cocks that give a long and satisfactory service
Factory: HARTFORD, CONN., U.S.A.
THE CANADIAN FAIRBANKS-MORSE CO., LTD., Halifax, St. John, Quebec, Montreal, Ottawa, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

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THE time to put Nonpareil Cork Covering on brine and ammonia lines is right now when they are dry and free from frost. The job will cost you less and will be much more satisfactory than if you wait until summer.

Nonpareil Cork Covering is easy to apply because it is made in accurately molded sections for all sizes of pipe and fittings. Except for a few simple tools everything needed is supplied with the covering. Any reasonably careful workman can apply it properly, quickly and inexpensively.

Nonpareil Cork Covering in the plant of the Sinclair Refining Company, East Chicago, Ill.

Send in your name to-day for "Nonpareil Cork Covering," a 64-page book on pipe line losses and insulation. It is filled with data—tables and information not available elsewhere—valuable wherever refrigeration is used. Without charge or the slightest obligation, his book will be mailed promptly on receipt of your request.

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Also manufacturers of Nonpareil Corkboard Insulation for cold storage and ice storage rooms; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines; and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Cork Covering

For Brine and Ammonia Lines

MAC GOVERN & COMPANY INCORPORATED POWER MACHINERY

114 Liberty Street - - - New York, N. Y.

2—Brand New Hydro Electric Units

4,500 KVA capacity, vertical type, approximately 130' head. Turbines built by I. P. Morris & Company. Generators built by General Electric Company. Complete switchboard and all auxiliaries both for turbines and generators.

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Jenkins Valves are made to serve. They are designed throughout for the **maximum** service, not merely the average—and tested in this regard before leaving the factory.

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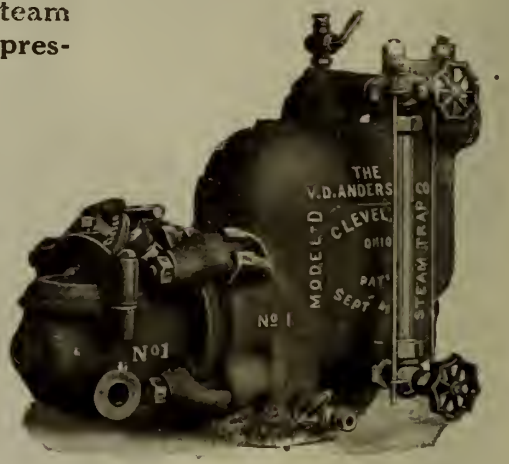
All parts are machined to solid gauges, thus ensuring absolute accuracy.

The trap is so constructed that you can change the valve and seat from high to low pressure or vice versa in five minutes without disturbing or unscrewing a single steam joint or pipe connection.

A removable strainer is part of the equipment. It prevents pieces of scale, packing, etc., from entering the trap.



We have a catalog to send you, containing a full description of the Anderson Steam Specialties. Write to-day.

The V. D. Anderson Company

1935 West 96th St., Cleveland, Ohio

Get the Maximum Power from the Fuel You Use

THE fundamental purpose of the boiler setting and the refractory lining is to keep the furnace heat in and the cold air out. Cold air inleakage checks the fire, cools the gases before combustion is complete and sends a large percentage of the heat units of your coal up the chimney.

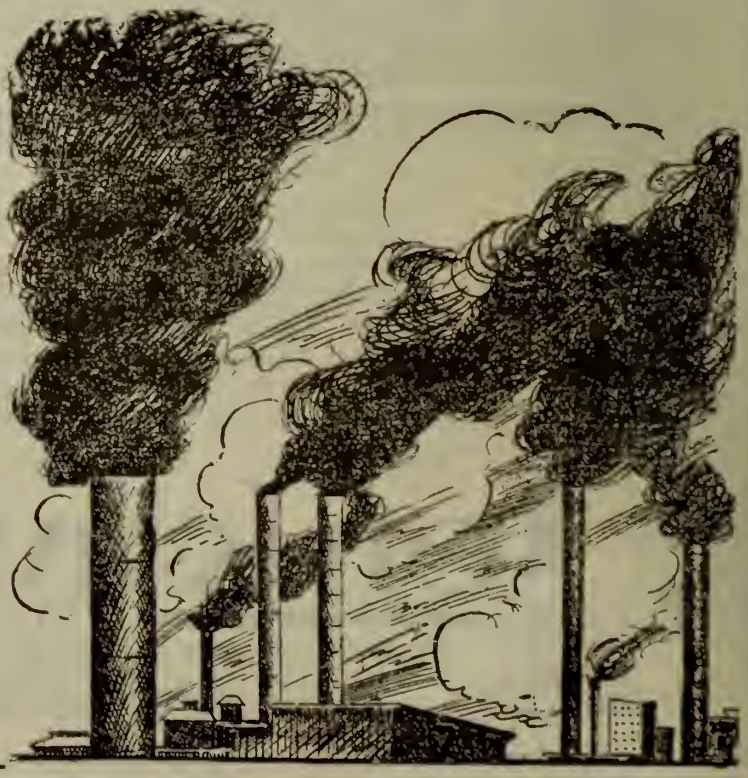
Separate fire bricks are little more than in place with fire clay when the heat begins to move them.

BETSON'S

REG. U.S. TRADE MARK PAT. OFF. PLASTIC FIRE BRICK

should be used to form in place a one-piece, jointless, monolithic furnace lining, including front arch and walls, side walls, bridge walls, combustion chamber and back arch, if any. Also, gas tight baffles should be formed of these same materials. Then you will not only be getting the most out of your fuel, but you will cut your repair bills to the minimum and will avoid the delays and shutdowns too often necessary with other types of boiler furnace linings and baffles.

We have an interesting and instructive pamphlet dealing with the uses for Betson's Plastic Fire Brick. Write for it.



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Canadian Distributors:
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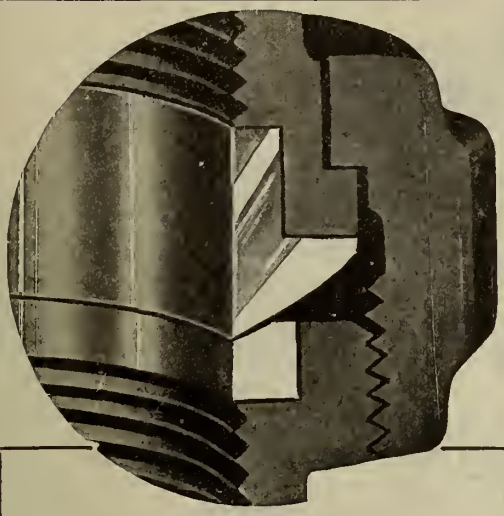

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NO DETERIORATION

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By using Dart Unions you can make connections easily and quickly—without bother—whether pipes are in or out of alignment.

There'll be no upkeep cost, no replacement cost—and no loss from leaks.

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CANADIAN MM

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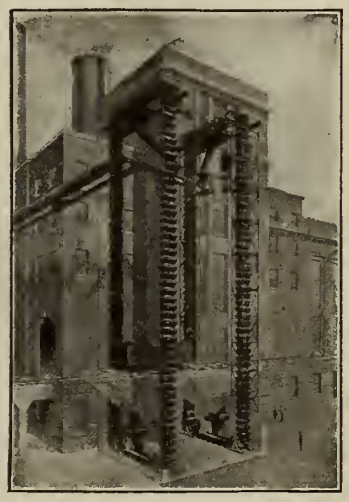
Made in Canada



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Capacity 960-8000 cu. ft. per hour
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Size of conveyor buckets range from
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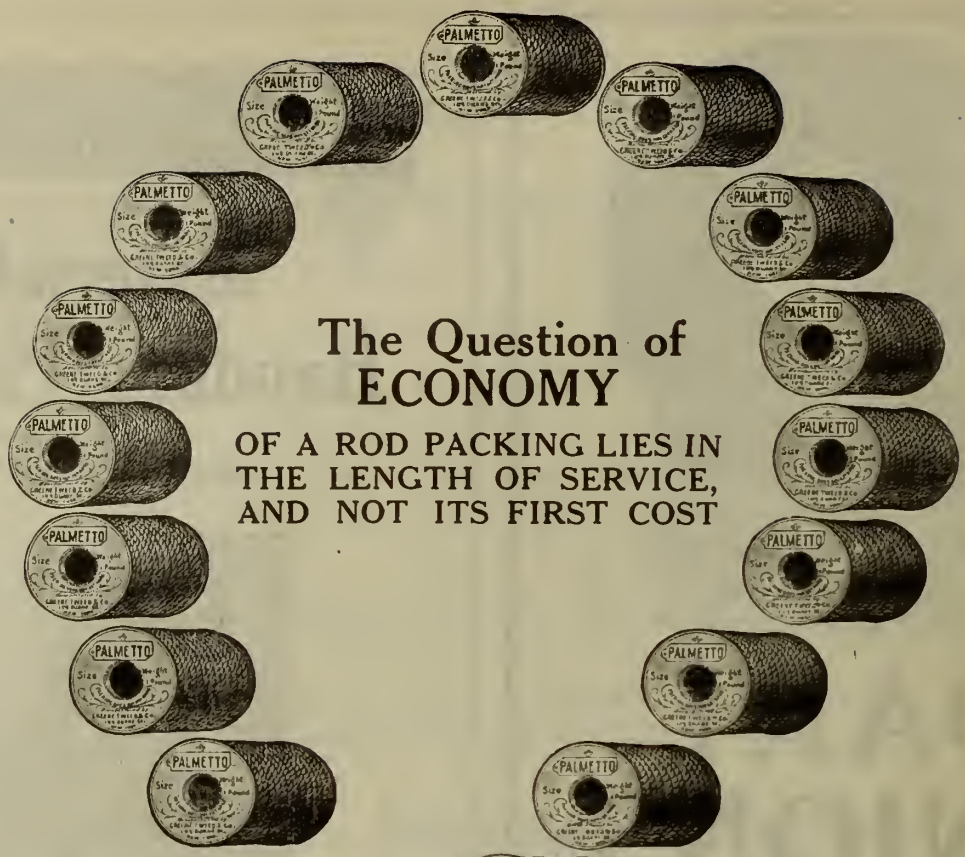

The Question of ECONOMY

OF A ROD PACKING LIES IN THE LENGTH OF SERVICE, AND NOT ITS FIRST COST

"PALMETTO"

gives longer service than other packings because it is made of a grade of asbestos usually considered too good for packing, but which needs no additional vegetable substance to give it the necessary strength at the expense of its heat-resisting quality.

TWIST
for valves.

"PALMETTO"

does not become hard like other packings, because each single strand has lubricant forced into it before braiding, which lubricant not only keeps it soft but so lubricates the rod as to prevent friction and wear of both rod and packing.

BRAIDED
for rods.

Let us send you sample of both braided and twist to test—no charge.

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Sole Manufacturers

Boiler Repairs Reduced by Superheating—

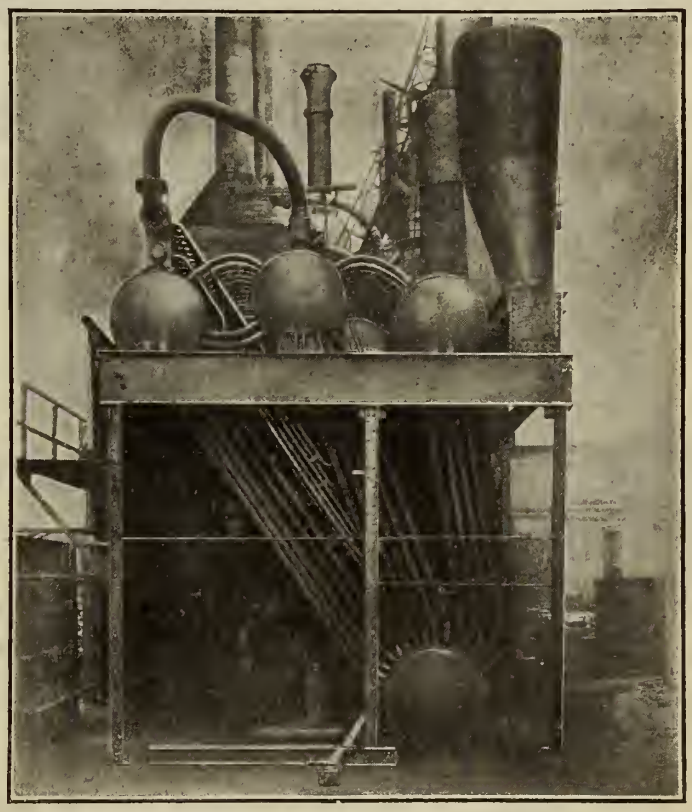
Overworked boilers are an expense.

Repair bills and delays are constant sources of worry when insufficient boiler capacity prevents shutting down once in a while to relieve a boiler of its load and to clean it properly.

Such conditions can result only in a forced shutdown, with its attendant expense for repairs and costly delays in production.

By applying Elesco Superheaters you obtain sufficient additional boiler capacity to enable you to draw a fire and rest a boiler. Your maintenance and repair bills are reduced.

Boilers equipped with Elesco Superheaters cost less to maintain.



Typical Installation of ELESCO Superheater on Sterling Type Boiler

ELESCO

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WORKS AT SHERBROOKE, QUEBEC

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all purposes.

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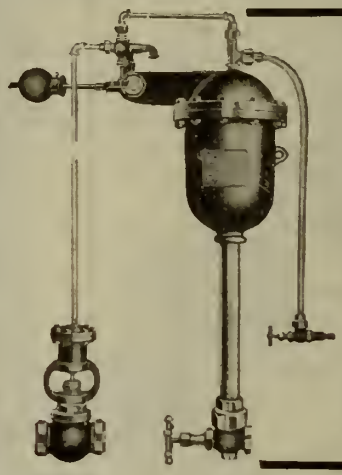

Make Sure of Constant Level and Stop Worrying

Eliminate the danger of boiler explosion due to low water or a wrecked turbine or engine due to high water by feeding your boilers automatically with

Vigilant Water-Feed Regulators

They hold the water level constant at middle gauge — the safest and most logical point — that insures better economy and protects the boiler against excessive expansion and contraction.

A paying investment for any plant.

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Also Manufacturers of the Fulton Pump Governor.

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Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes

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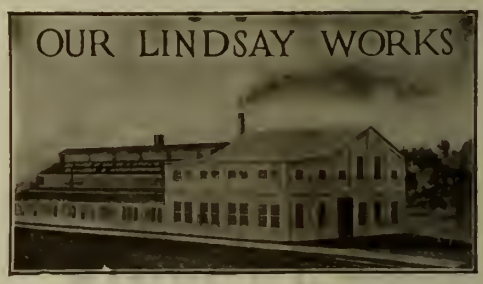

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BE WISE AND CORRESPOND WITH

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American Gauges and Pop Safety Valves are

Simple in construction. Durable and Efficient in service.

Why not specify AMERICAN and profit by our seventy years of experience?

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., LTD., Montreal, Quebec, Toronto, Halifax, St. John, Ottawa, Hamilton, St. Catharines, Windsor, Winnipeg, Regina, Saskatoon, Calgary, Vancouver, Victoria.

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PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

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FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

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Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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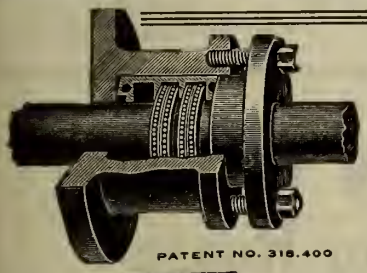

PATENT NO. 318,400

PAT. NO. 500,898
" " 534,104
" " 602,628
" " 654,541
" " 654,542
" " 725,388
" " 774,490
" " 775 193
" " 775,194
" " 791,300
" " 805,689

PAT. NO. 829,118
" " 830,530
" " 856,103
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HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

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A British Made Glass that stands in a class by itself for Quality

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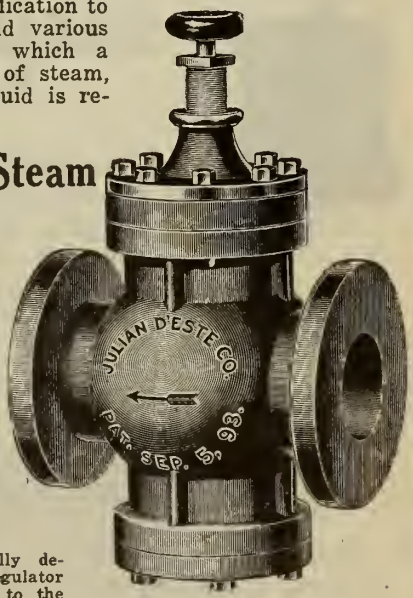
Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the



Improved Steam Pressure Regulator

has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

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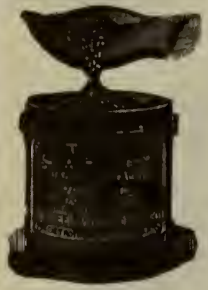
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METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

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Are You Receiving "Power House" Regularly?

Note the address on the label on this paper. If it is not your present correct address please notify us at once. Mark plainly your old address, followed by the new address, as follows:

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PETRIE and SATISFACTION Mean One and the Same

To Buyers of--

New and Used Power Plant Equipment

As we examine our records from time to time it is with pride we watch the evergrowing list of Petrie customers. We feel that our endeavors in giving quality, service and satisfaction have not been in vain.

Steel Tanks: Any Capacity and Purpose.
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Write for full particulars.

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SHAKING AND DUMPING GRATES

Use 10% Less Coal!

FIREBRICK WORK

The one sure way of securing lasting satisfaction in your firebrick work is to call in "Safety First" Sexton.
Grate Bars and Repairs to Shaking Grates and Boilers of all sizes.

Many of the biggest firms throughout Ontario have installed Nonpareil Shaking and Dumping Grates under our free trial offer. Why don't you? We guarantee that they will reduce your coal bill at least 10 per cent.!

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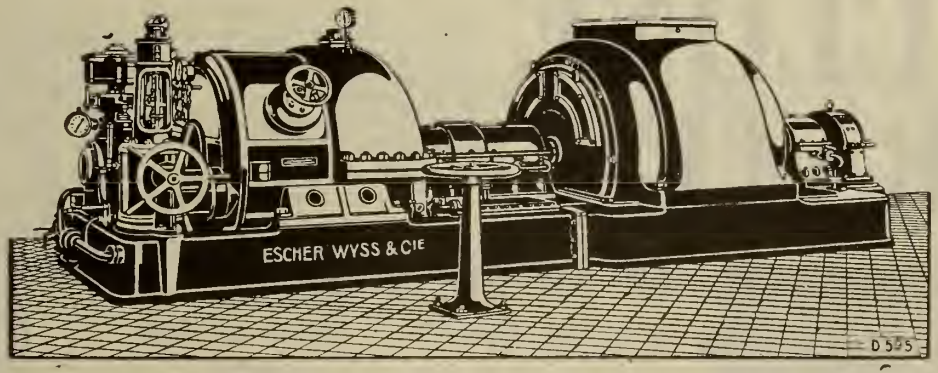
Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

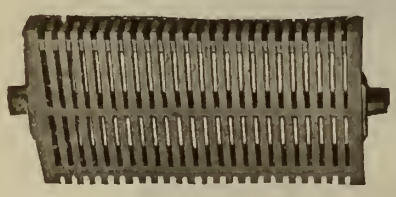
Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

CYCLONE GRATES

No Clinkers—No Waste

You can burn screenings and low-grade soft coal satisfactorily if you are a user of Cyclone Grates. Their scientific design ensures perfect combustion even when low-grade fuels are used. Their 60% air space and 90% under-draught means no clinkers—no waste! Their jarring, shaking movement sifts all the ashes through—the good fuel remains. Write for particulars of our 30 days' free trial offer.

Note:—Have you details of our new pin-hole grate bars for burning hard coal screenings?



The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street Phone G. 3660 Toronto, Ontario

AGENTS:

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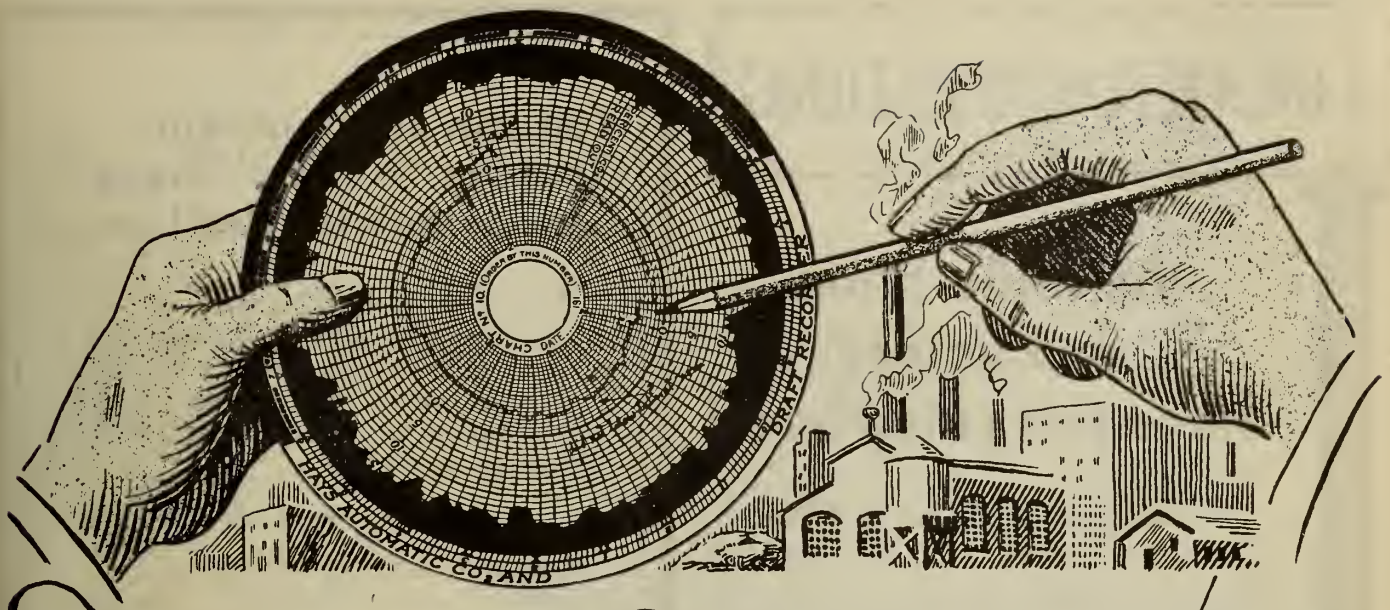

The Chart that Protects the Plant from Waste

Just as the chart protects the ocean liner from running onto rocks, the boiler-room is protected from the rocks of waste by the chart of the Hays Recorder.

In many plants, changing from night load to day load is attended by a period of low efficiency and much waste of fuel. Not so in the Hays equipped plants. Hays Charts keep firemen so well informed about conditions of their fires, draft, etc., that they are able to steer away from wasteful practices.

The above chart shows intelligent firing. At 8.15 a.m. the draft was doubled to carry the day load and the CO_2 started to drop—but the fireman saw what was happening—and increased the thickness of the fire, thereby bringing the CO_2 back to 15%. The Hays Chart supplies accurate and timely information, essentials to intelligent firing.

Let us give you a few facts on the importance of combustion efficiency in your boiler-room.

Awarded Certificate of Merit by Franklin Institute.

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Note below the result of a very severe test in which the "Resisto" was tested with several well-known brands of glasses.

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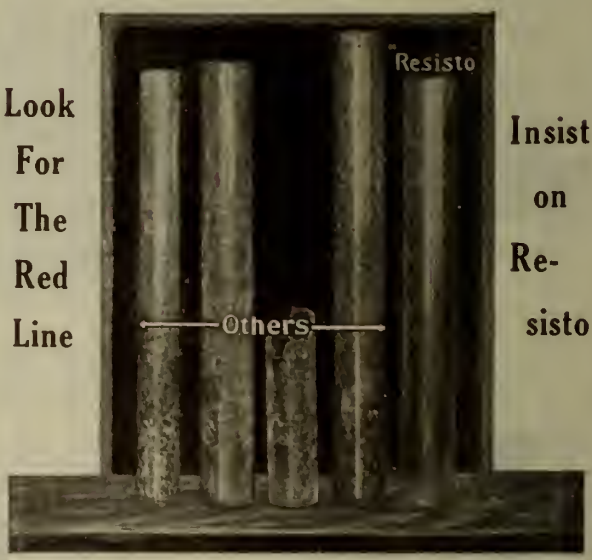
Look For The Red Line



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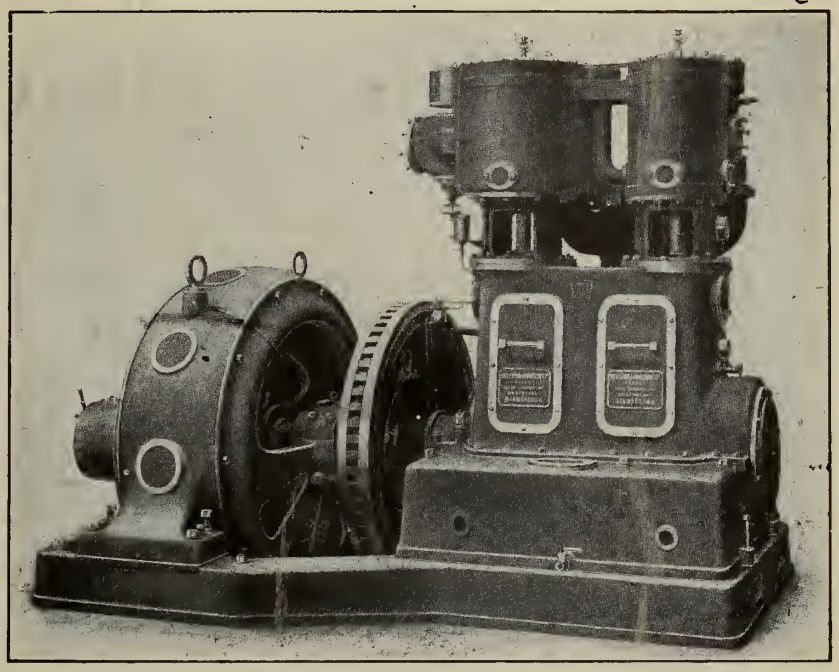

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Belliss & Morcom

Engines and Air Compressors

When one article or machine is chosen in preference to another, there is generally a carefully worked out reason. Take for example Belliss & Morcom Engines and Air Compressors. They have established definitely and decisively the fact that their users derive from them longer and more efficient service than from other makes. This accounts in a great measure for the "stand in" Belliss & Morcom equipment has with practical engineers, and explains why Belliss & Morcom Engines and Air Compressors are found in many of Canada's most modern engine rooms.

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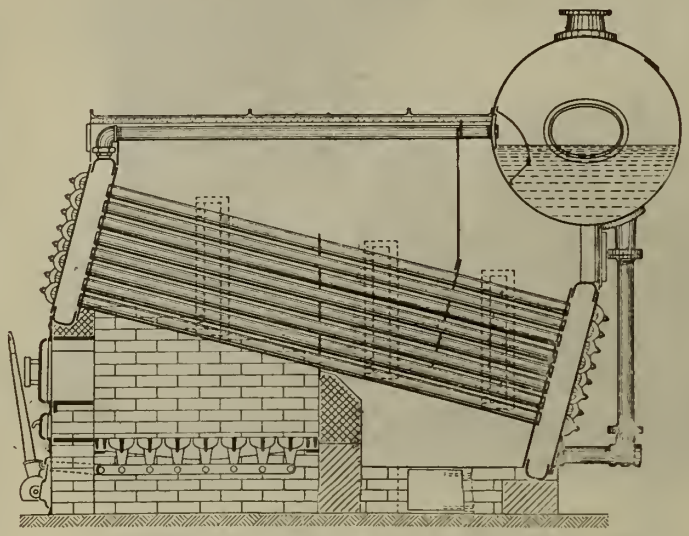

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It has a steel case lined with asbestos and firebrick and requires no brick setting.

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That is why modern paper mills are equipping their power plants with COPPUS Turbo Blowers to maintain constant steam pressure under varying conditions of load, fuel, and weather.

For instance, the COPPUS Blowers shown above operating in the plant of the Hampshire Paper Company, makers of good paper, at South Hadley Falls, Mass., have kept steady steam pressure with very satisfactory results. Peak loads are quickly met, steam pressure is always constant, and cheap fuel is economically burned.

COPPUS Turbo Blowers are helping out engineers and speeding up boilers in power plants the country over. Their good work is not confined to the paper industry—it extends wherever power is used and coal is burned. If they are not already working for you it is likely that they could save time, money and labor in YOUR boiler room.

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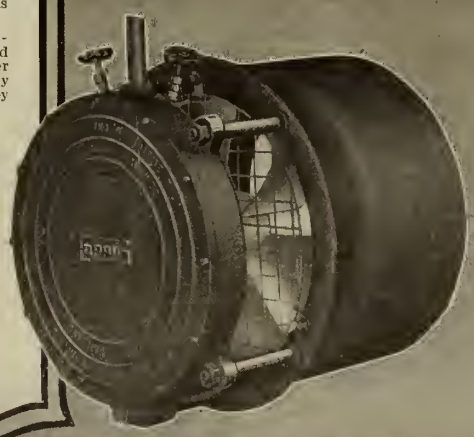

COPPUS TURBO BLOWER

Made in Canada

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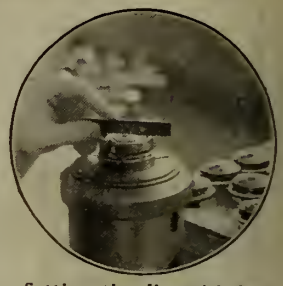
Every Dunham Trap Is TESTED



Setting the disc with hair-line accuracy. This adjustment is permanent.

Every Dunham Radiator Trap is permanently adjusted at the factory. It never needs attention in service when used within the range of pressure for which it was designed. Dunham Traps are "set by test." Preliminary setting is made with precision tools and gauges to a hair line. Then, **after that,** each individual trap is tested as illustrated to prove that it opens for air and water but closes tight against steam.

There is nothing uncertain, variable or weak about the motive force in a Dunham Radiator Trap. When steam comes into contact with the thermostatic disc, it closes positively with a pressure of 14 pounds against the steam.

There is a Dunham Trap for every need. Full details of all Dunham Specialties will be found in Special Bulletins, covering each of the Dunham Specialties. Write for the one you wish.

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SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

American-Marsh Centrifugal pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—
Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN

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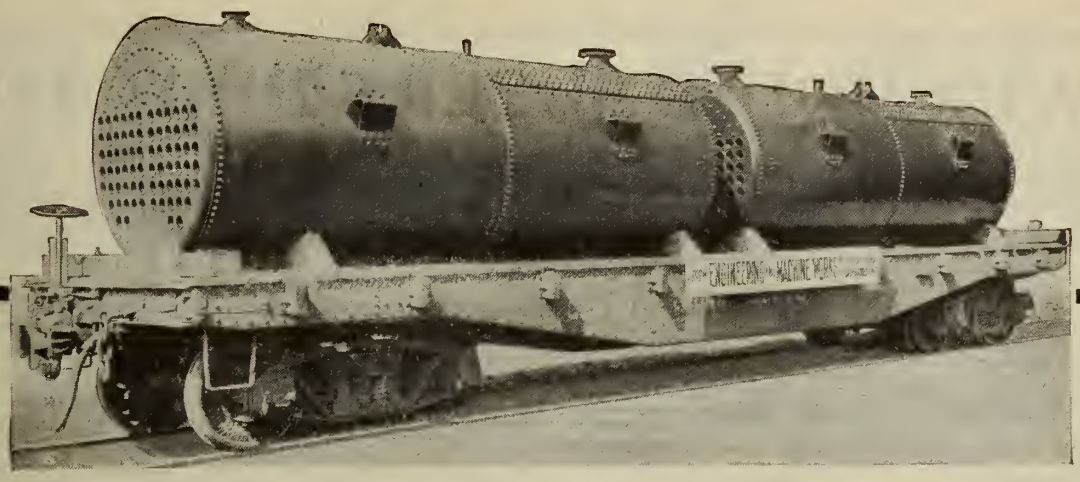

Why We Say "BUY THAT BOILER NOW"

Read these excerpts from a recent editorial in the Montreal "Daily Star":

"There cannot be ground for serious apprehension even concerning the immediate future of Canada."

"There is no immediate prospect that prices will fall to pre-war levels. Indeed there is a common opinion that in many branches of business the reductions in prices have been excessive and that there will be a recovery to higher figures. Nor is there any such reduction in buying as the pessimists suggest. The volume of retail business is very large and the bulk of the people are purchasing freely. It must be remembered, too, that lower prices will stimulate buying."

"Stocks will be reduced and regular orders to the manufacturers follow."

"Canada has resources such as she never had before. There are hundreds of millions of Dominion bonds in the hands of Canadian holders. The interest goes through Canadian pockets into productive domestic enterprises."

"From November until April the banks and the Government will draw $5,000,000 and thereafter $10,000,000 monthly until the $150,000,000 owing to the Dominion by the Imperial Government is repaid."

"It is true that adverse exchange stimulates purchase of goods in Canada, and thus directly benefits Canadian manufacturers and Canadian labor. Through the rate of exchange we also have an advantage in export over United States manufacturers and producers."

"For 1914 our exports were $431,588,439 and for the last fiscal year $1,289,492,098."

"There is no weakness in the financial situation to create a suspicion of alarm. When the strain of moving the crop has been lessened commercial credits can more easily be maintained and perhaps extended."

"There is a great reserve of purchasing power in the country. The savings deposits in the banks of Canada on October 31st were $1,271,275,751, as compared with $659,806,682 on October 31st, 1914.

"An outward movement of people always follows a war in Europe. To immigration from the Old World will be added a great and continuous overflow from the United States. During the last year 100,000 immigrants entered the Dominion. The Minister of Agriculture for Ontario, who has just returned from Great Britain, believes that in the Spring 10,000 British tenant farmers will come to that province.

"If we are wise and prudent and confident, if we bear with serenity the inevitable penalties of readjustment which no people in the world can escape, and if we will remember that many of us have had a harvest of material gains long and abundant, we will soon emerge without any vital disaster into a new era of progress and prosperity."

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St. Catharines, Ontario

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

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McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
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Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
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Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
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Empire Mfg. Co., Ltd., London, Ont.

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International Chemical Co., Toronto, Ont.
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CHAINS, AUTOMOBILE ENGINE
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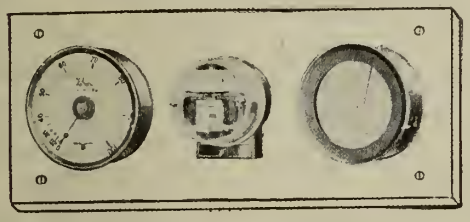
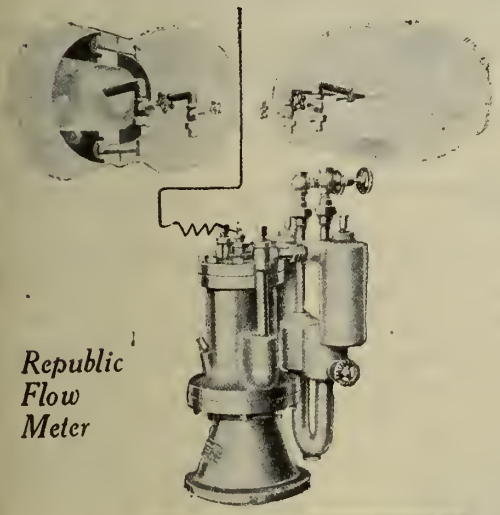
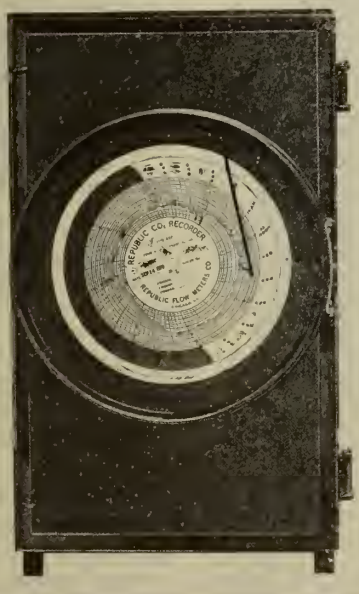
Republic

TWINS A Cost Cutting Combination





Republic Flow Meter



Republic CO_2 Recorder

REPUBLIC FLOW METERS AND CO_2 RECORDERS

Have Become a Vital Necessity in the Economical Operation of Power Plants

AT the present time itemized costs of manufacturing are receiving attention such as they never received before. This being the case, it is essential that every possible means be taken whereby constant and accurate check can be kept on all processes which go to make up the finished product.

Two items which have received little, if any, attention up to the present, are the amount of steam used in the various processes and the amount of steam produced per ton of coal consumed.

You cannot improve your conditions unless you first know what they are.

THE REPUBLIC FLOW METER and CO_2 RECORDER are instruments designed to give you this information and also to keep a constant check on these conditions, the FLOW METERS giving the total amount of steam produced by the boilers, or consumed by the various departments, and the CO_2 RECORDERS giving a record of the combustion conditions in the furnace, and thus showing definitely at all times at what efficiency the fuel has been burned.

The installation of new boilers has been proved unnecessary by the aid of the FLOW METERS, enabling the boiler plant to be maintained at a very much higher efficiency than was possible without their aid.

The CO_2 RECORDERS continuously give a record of combustion conditions, and in this way increase the production of steam per pound of coal to a very large extent.

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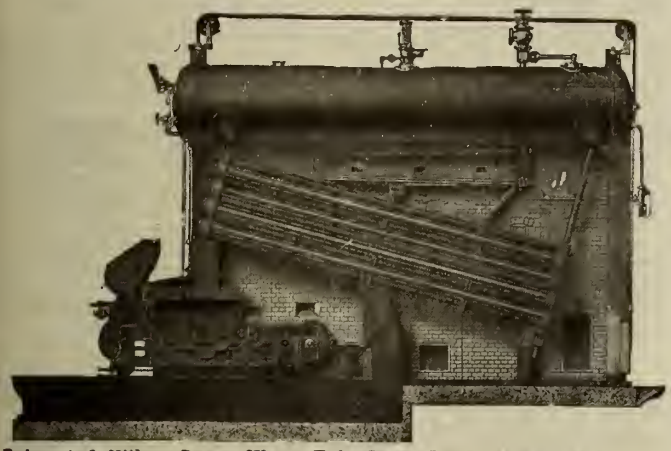

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TORONTO OFFICE, TRADERS BANK BUILDING

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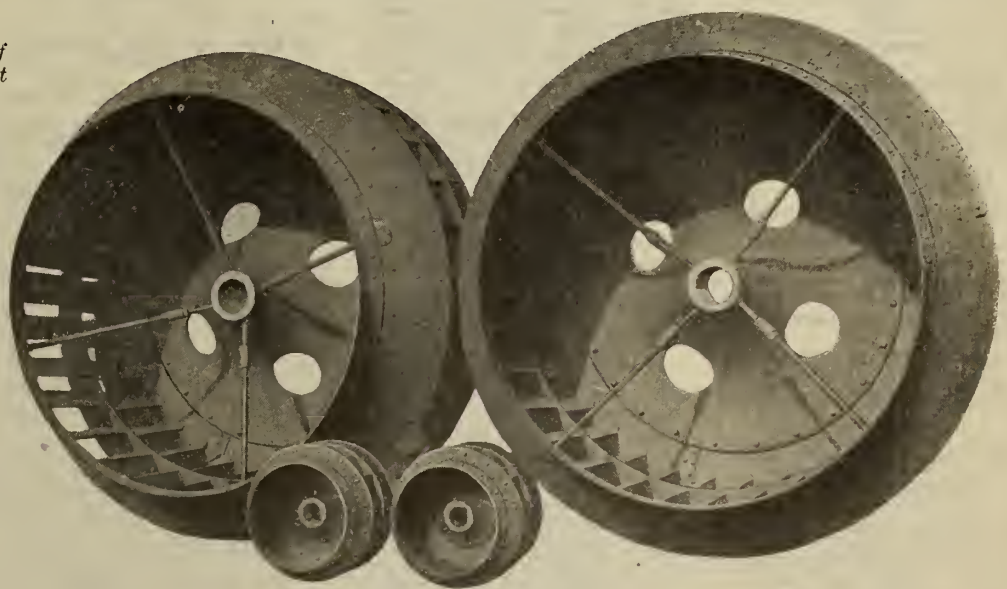

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Sanford Riley Stoker Co., Worcester, Mass.

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Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holdan Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliahue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall. Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
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MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

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R. G. Long & Co., Toronto, Ont.

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Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford
Williams Machinery Co., A. R., Toronto

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C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliahue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Alliway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
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W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

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Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
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Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

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MacGovern & Co., Inc., Montreal, Que
Waterous Engine Works Co., Brantford.

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Garlock Packing Co., Hamilton, Ont
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HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

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Can. H. W. Johns-Manville Co., Toronto
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

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Pratt & Cady Co., Inc., Hartford, Conn.

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Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

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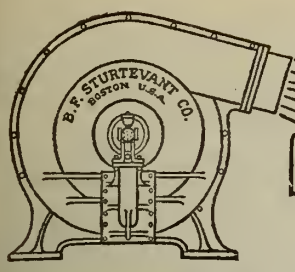
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.



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Penberthy Injector Co., Windsor, Ont

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Sanford Riley Stoker Co., Worcester, Mass.

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Lunkenheimer Co., Cincinnati, O.
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Yarnall-Waring Co., Philadelphia, Pa.

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
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Lincoln Electric Co. of Can., Ltd., Toronto
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Ministry of Munitions, London, England
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MOTOR VEHICLES
Ministry of Munitions, London, England.

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E. H. Kellogg & Co., New York.

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OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

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Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
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OILING SYSTEMS
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Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

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Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
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Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

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Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

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Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

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Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
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Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

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Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

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PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

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J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

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J. C. Wilson Mfg. Co., Ltd., Belleville.

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Crane's Limited, Montreal.

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PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr & Eng. Co., Ltd., Lindsay.

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Crane's Limited, Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

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Goldie & McCulloch Co., Galt.

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Holden Co., Ltd., The, Montreal.

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Holden Co., Ltd., The, Montreal.

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Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

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Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

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Pratt & Cady, Hartford, Conn.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

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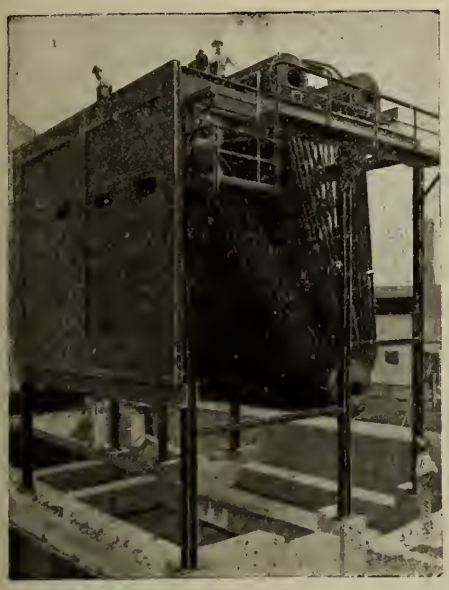

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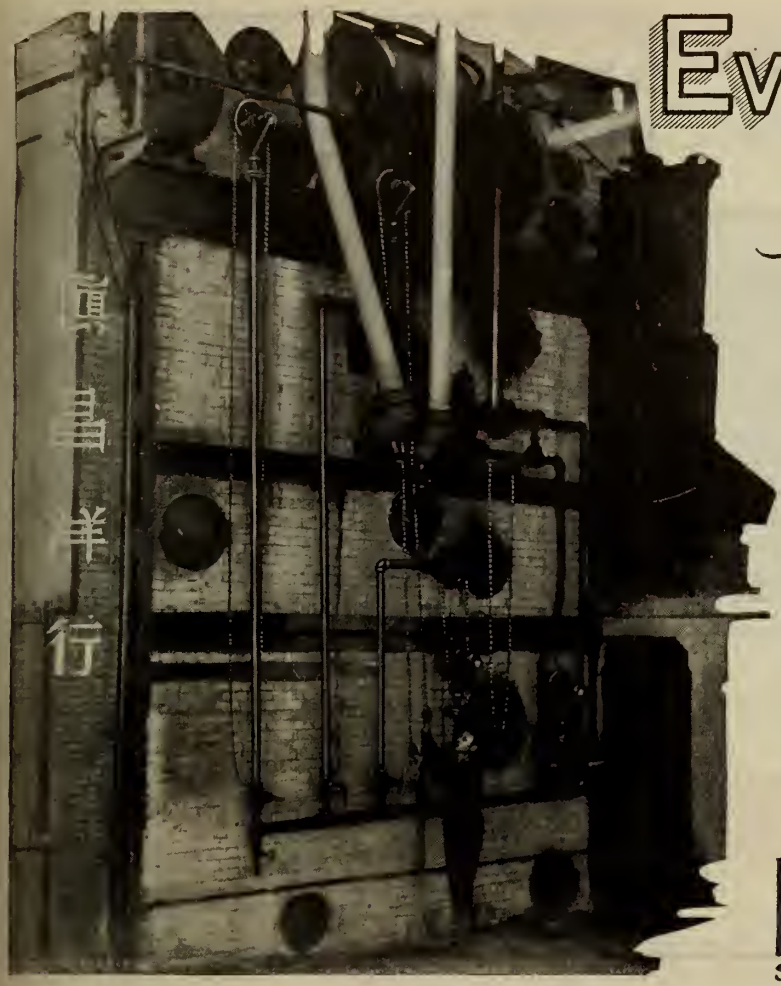

Even In China
Clean Boilers Mean Greater Profits

Who thinks of China—the "unmoved and unmoving"—in terms of fuel and labor saving devices?

True to tradition ancient Cathay reverencing the customs of the past should calmly ignore the methods and implements of twentieth century "efficiency."

But there is a new spirit in the Oldest of Empires. Machines are replacing hands. Here and there an industrial center is springing up.

And mark you——!

China's manufacturing plants of 1921 are equipped with the best obtainable modern high-speed, high efficiency machinery.

Take Diamond Soot Blowers for example. The installation shown on this page, that of the Yufoong Cotton Mills at Chengchow, Honan Province, is only one of twenty or more installations made during the past year.

With the cheapest labor in the world China is eliminating hand cleaning of boilers. With vast untouched supplies of coal and oil, China is saving fuel through the use of Diamond Soot Blowers.

Even in China clean boilers mean greater profits!

Here, then, is a striking lesson which can well be scanned by every Canadian business man. If Diamond Soot Blowers are a profitable investment in such a land as China, how much more essential and profitable must they be in Canada to-day?

If your boilers are not equipped with Diamond Soot Blowers, and you want to save fuel and labor, write for Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ontario

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

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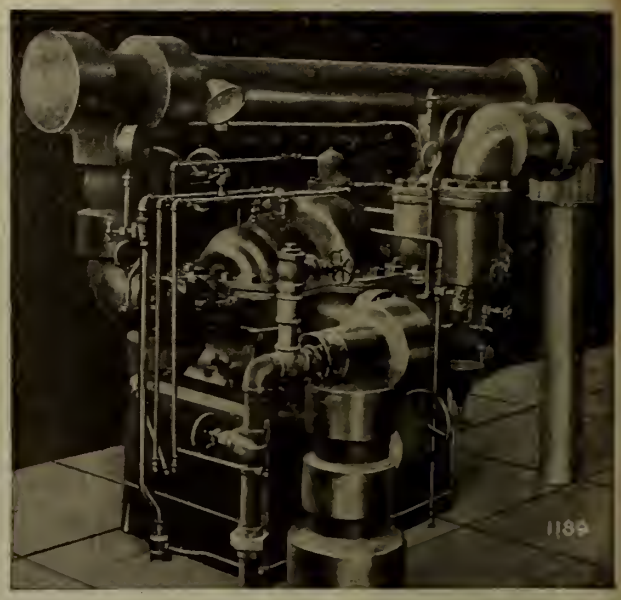

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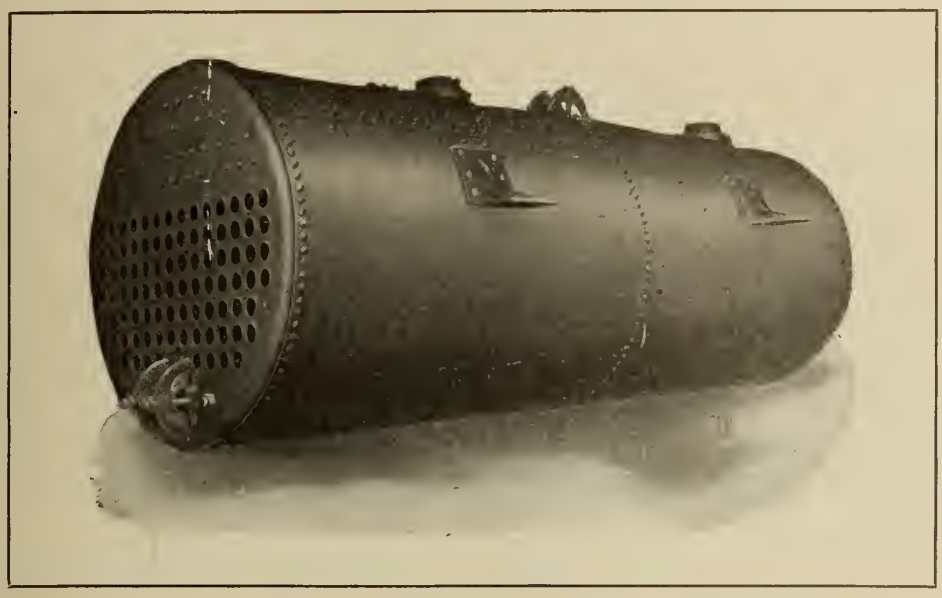

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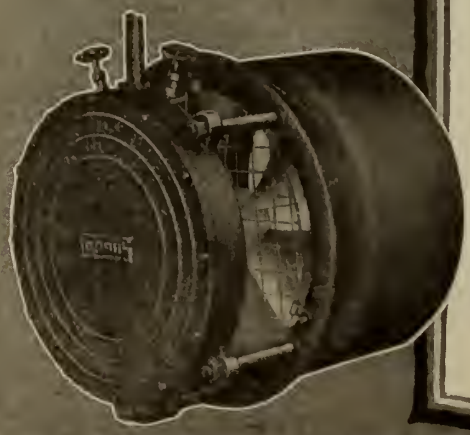

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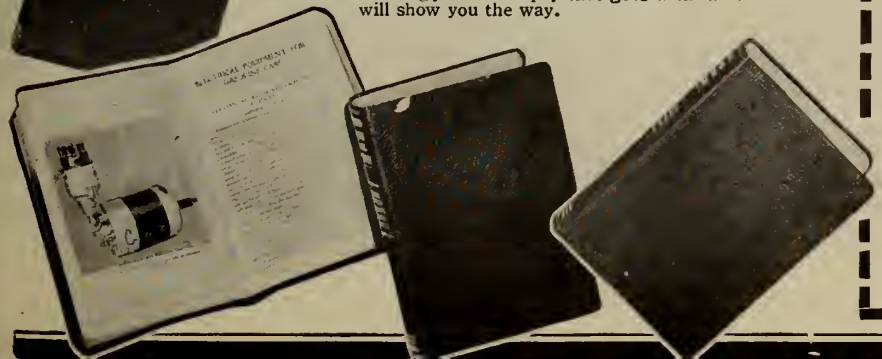

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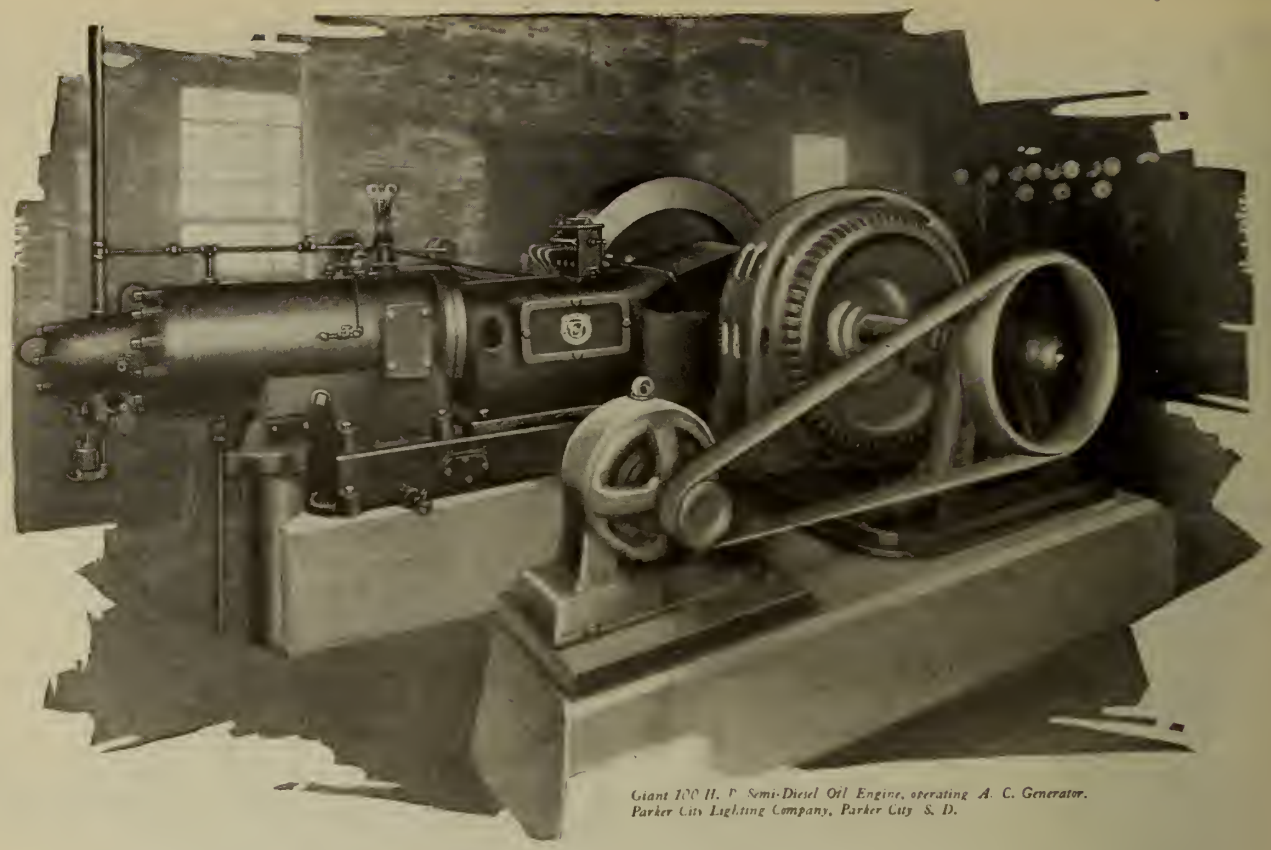

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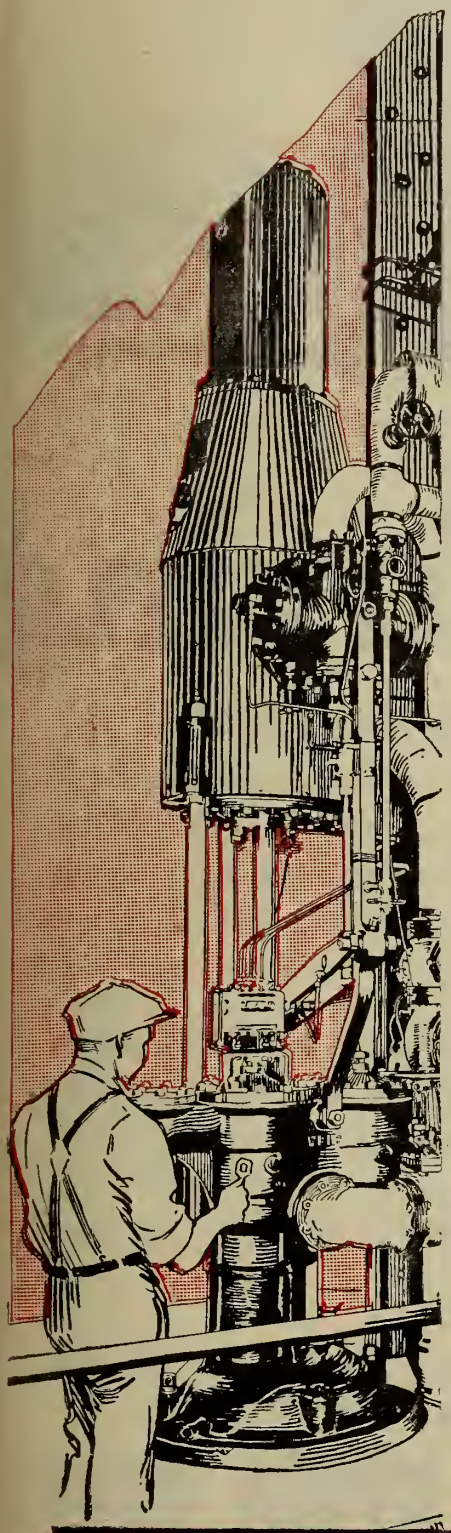

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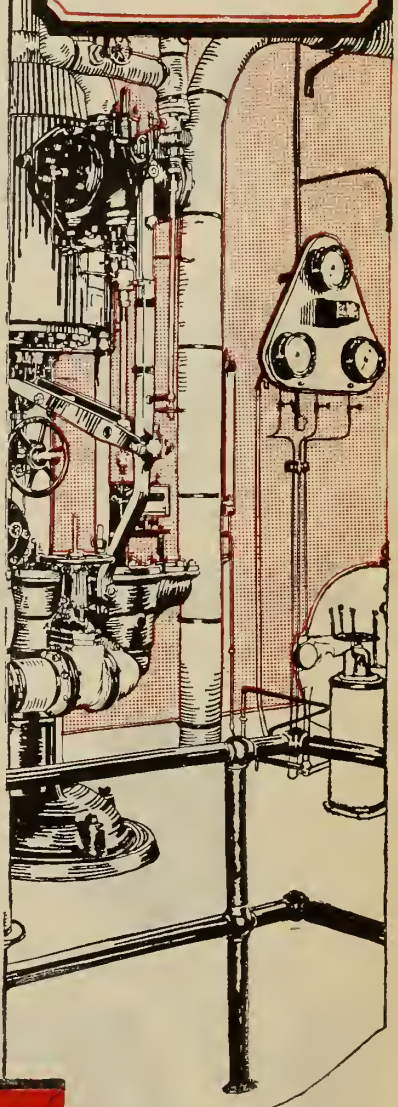

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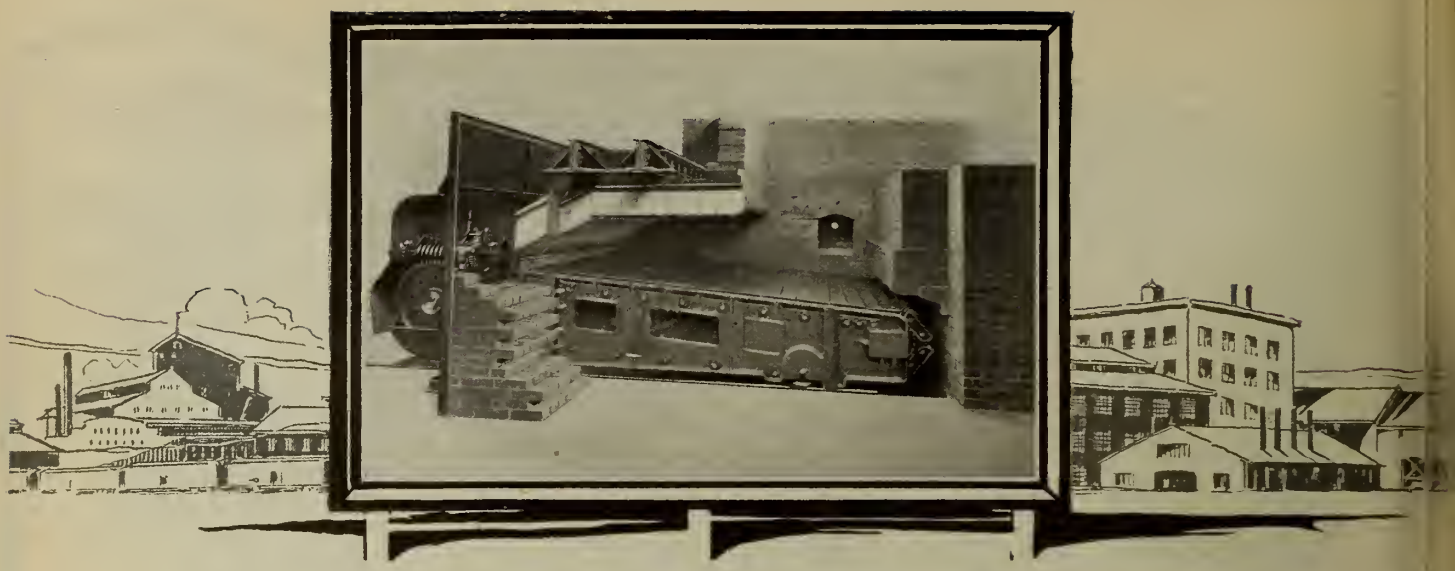

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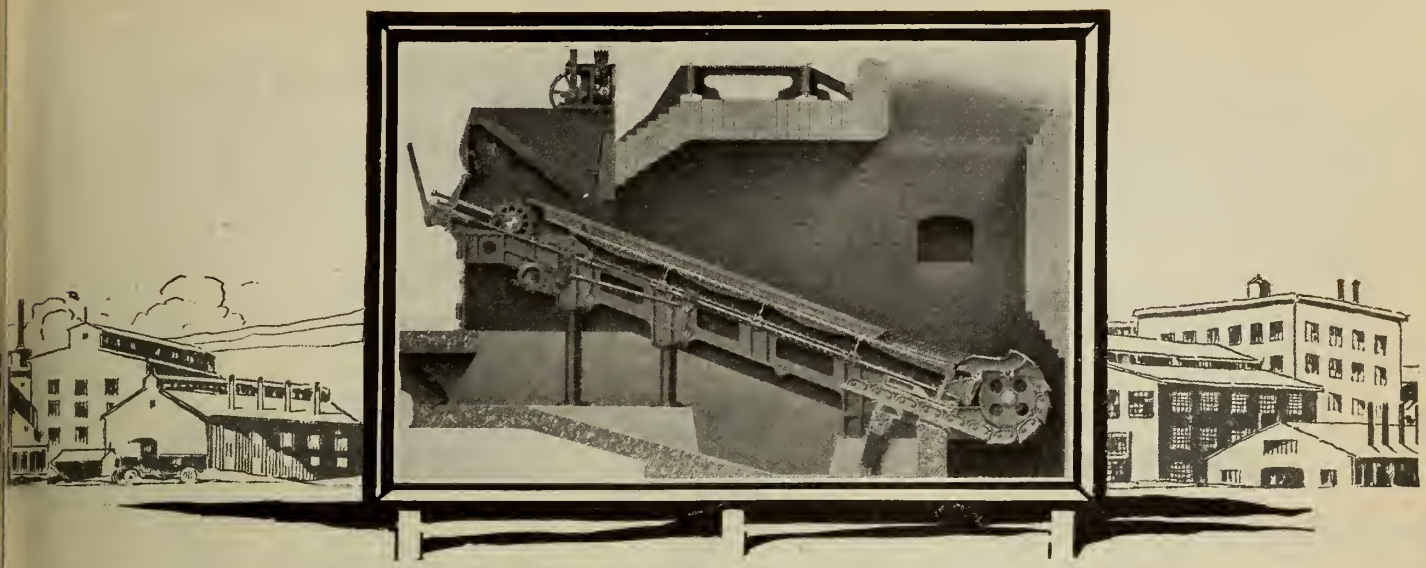


The Stowe Stoker—the forced-draft type whose fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit

L-C Stokers?

A REAL GUARANTEE

A guarantee can be worded so as to mean a great deal—or nothing at all. With us, the *spirit,* not the letter of the guarantee, is the vital thing. Briefly, *we guarantee satisfaction to every customer.*

A complaint has never come to our attention that we have not handled promptly and in a manner entirely satisfactory to our customer. We have been in business since 1844. This means that we have rendered satisfactory service in the past. We intend to remain in business for many years to come, which means that we must keep on giving satisfaction.

Only to *satisfy* a customer does not fully meet our conception of service. We aim to give him such a full measure that it becomes a *pleasure* for him to do business with us.

Branch Offices:
New York, 504, 50 East 42nd St. Chicago, 1366 Peoples Gas Bldg.
Pittsburgh, 901 Oliver Bldg.

PROCTER & GAMBLE PRODUCTS - EST. 1837 -

Procter and Gamble

LINK-BELT

Link Belt Company

International Harvester Co.

D138

CHRISTY

FOUNDED 1844 ST. LOUIS

The York Service Organization

York QUALITY Products and Expert ENGINEERING Advice are brought into close proximity to every user of Ice Making and Refrigerating Machinery by the York Service Organization.

The close, personal touch afforded by this organization in all our dealings with our customers, and the prompt service we are thereby enabled to render, has contributed in no small degree to the Confidence which the Trade places in York QUALITY Products.

Whether you are thinking of installing a new plant, require engineering advice, or need supplies for your Ice Making or Refrigerating Plant, it will pay you to write our nearest Branch.

MECHANICAL QUALITY YORK SERVICE **REFRIGERATION**

The Trade in the Dominion benefits by the ability and experience of this Organization through four regularly established Service Stations.

Canadian Ice Machine Company

TORONTO
Villiers & Munition Sts., Eastern Harbor Terminals

MONTREAL
324 Craig St. West

WINNIPEG
85 Lombard St.

CALGARY
605 Second St.

YORK MANUFACTURING CO., YORK, PA., U.S.A.
(Ice Making and Refrigerating Machinery exclusively)

FOR REFRIGERATING EQUIPMENT
USE

P&H WROUGHT PIPE

GENUINE WROUGHT IRON ∴ STEEL
LAPWELD ∴ BUTTWELD

SPECIAL REDRAWN PIPE for AMMONIA PURPOSES

WROUGHT PIPE BENDS
ALL KIND AND SIZES

FLANGED PIPE JOINTS
ALL TYPES

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office:
100 Church Street, Toronto, Ont.

This Mark On Belting

STANDS FOR

D. K. McLAREN'S

BRITISH-OAK-TANNED
FLAWLESS BACK LEATHER

EVERY D. K. McLaren Belt has the Oak Leaf stamped plainly upon it.

For many years this mark has been a guide to efficient, economical belt service for many of Canada's prominent industrial power plants.

Let it guide you, as it is guiding others, to satisfactory belting service.

Just fill out the coupon below and we gladly help you find out what users think of D. K. McLaren's Belting. We'd like you to profit by the experience of others.

Back Leathers—This is the best portion of the hide for belting purposes. Every inch of D. K. McLaren Belts represents Flawless Backs of the hides of the choicest steers.

British-Oak-Tanned—The most approved process known for preparing belts for hard service. Every bit of the hide's natural strength is preserved in D. K. McLaren's Belts by the expert use of this famous process.

D·K·McLAREN LIMITED

GENUINE OAK

D. K. McLAREN, Limited,
Gentlemen,—Please put me in touch with some users of your belting.

Name .....

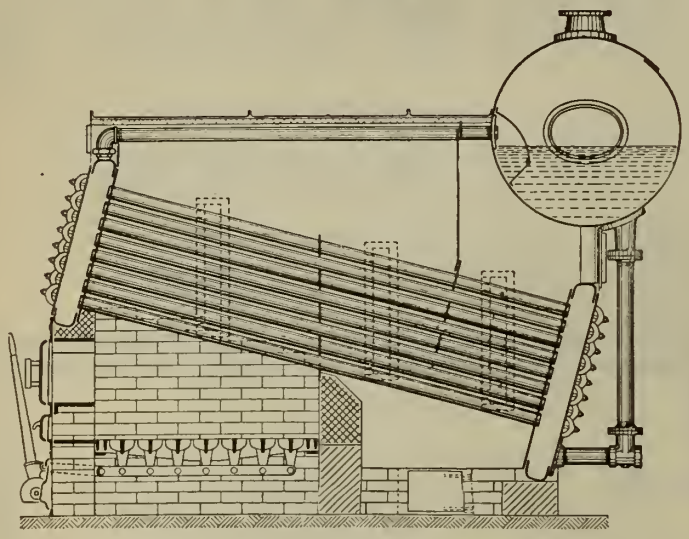
Address .....

Firm ..

HEAD OFFICE AND FACTORY:
351 ST. JAMES ST., MONTREAL, P.Q., CANADA

VANCOUVER, B.C.	TORONTO, ONT.	ST. JOHN, N.B.
334 Cordova West	194 King St. West	90 Germain St.

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N.S.

Montreal Office:
16 Cathcart Street

Toronto Office:
20 Victoria Street

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

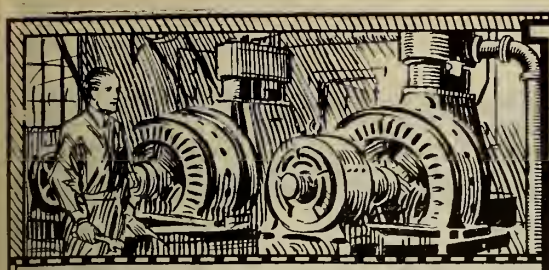
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.



MINISTRY of MUNITIONS
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The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
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Motor Vehicles
Agricultural Machinery
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Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

CUT YOUR PRODUCTION COSTS

After five years of unequalled industrial activity comes a breathing spell that provides the opportunity for long-deferred repairs and improvements that will enable you to *cut your production costs in the future.*

At one plant where Riley Underfeed Stokers were recently installed, six boilers equipped with Rileys easily carry the load that ten boilers with another type could scarcely meet.

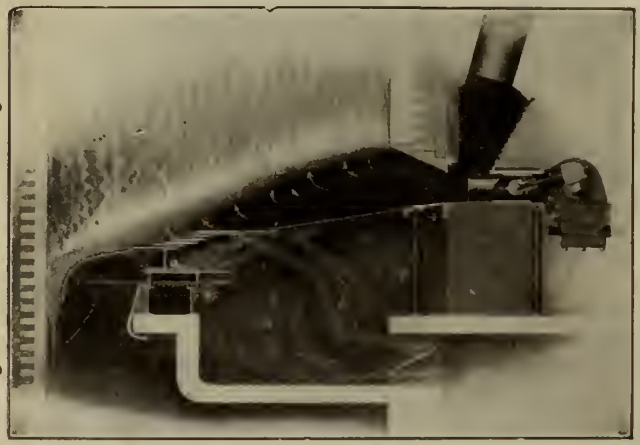
Not only this but a cheaper grade of coal is being burned with a saving of 25 to 30% in amount of fuel used.

Consider carefully what such savings would mean in your plant and you will decide that *now* is the time to investigate and install Riley Underfeed Stokers.

Let us send you our Catalog HR-3.

For information on the Murphy Automatic Furnace for small plants, see last month's advertisement, or send for Murphy catalog HM-2.

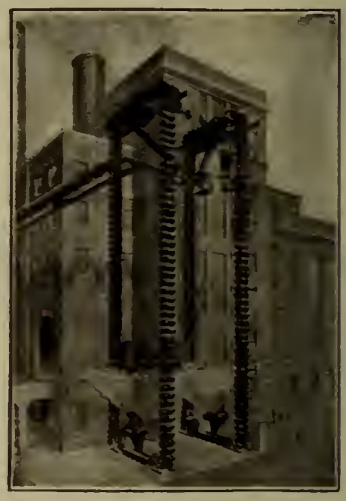
Sanford Riley Stoker Company
Worcester, Mass.



"MEAD-MORRISON"

Material Handling Plants

Made in Canada



McCASLIN GRAVITY BUCKET CONVEYOR

Capacity 960-8000 cu. ft. per hour
20-300 tons coal per hour

Size of conveyor buckets range from 15 inch square to 34" x 36"

STEAM HOISTS
SKIP HOISTS

Dependable Service

AGENTS:
Harvard Turnbull, Toronto.
Kelly Powell, Winnipeg.
Robert Hamilton, Vancouver.
Ferguson and Palmer, London, Eng.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT

You'll Know It By The Diamond Trade Mark

Dependable performance is guaranteed the buyer of Diamond Trade Marked Valves.

The name "Jenkins" within a Diamond Mark cast on the valve body—every **genuine** Jenkins valve carries it, a protection to the customer against inferior imitations.

And whatever the service, whether for steam, water, oil, air, gas or chemicals, genuine Jenkins Valves will prove safe and dependable.

Jenkins Valves are made to serve. They are designed throughout for the **maximum** service, not merely the average—and tested in this regard before leaving the factory.

Supply houses everywhere carry a complete stock of Jenkins Diamond Trade Marked Valves. Catalog No. 8 (free on request) will show you how comprehensive the Jenkins line is—a valve for every purpose.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros.

LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal Can.

TORONTO *European Branch* VANCOUVER

6 GREAT QUEEN ST., KINGSWAY, LONDON, W.C.2. ENG.

AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

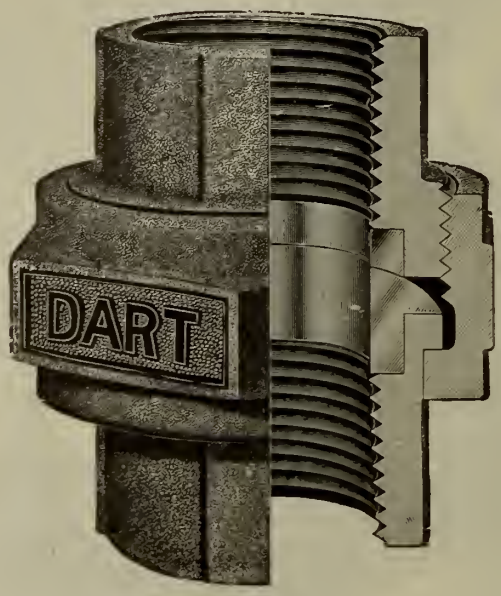
DART UNION PIPE COUPLINGS STAY TIGHT

Dart Unions

Make a joint that is proof against deterioration. A joint that will never loosen up and leak.

Their permanent efficiency is due to the non-corrosive Bronze Face and Seat and the Heavy Malleable Iron Pipe Ends and Nut which will not stretch or pull apart under heavy pressure or strain.

They ensure a Leak-Proof Service which leaves no loopholes for complaints.



Dart Unions

Pipe lines are easily connected up, thus effecting a "first cost" saving. They are there to stay until deliberately loosened with a wrench.

The Face and Seat being ball-shaped permits easy and perfect connection even if pipes are out of alignment.

Dart Unions always satisfy. Specify Dart Union pipe couplings in your next jobbers' order.

Manufactured by

DART UNION COMPANY, LTD., TORONTO

DURABLA

TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on

Every Glass

TESTS OF HIGH PRESSURE GAUGE GLASS

Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

Tensile Strength—Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.

Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

Another Call for Mason Service!

Mason No. 55
Pump Pressure
Regulator

Mason Standard
Bronze Reducing
Valve

Why--

Mason Service and Mason Appliances are in continual demand to-day by Power Users everywhere. Whether it be pressure regulation, engine or pump control, damper or blower regulation, or condensation drainage or returns, there is a Mason apparatus to handle it. And the thousands of Mason devices giving more than satisfactory service in critical positions is a silent testimony to the thoroughness of Mason design and construction.

No other devices work so accurately, wear so long nor accomplish their purposes so fully as the Mason. Once installed they require little attention and always bring "repeat orders."

This is aided by Mason Service—a service constituting a staff of expert engineers, each a specialist in the application of certain of our devices. It is their duty to aid and advise the most economical equipment compatible with efficiency.

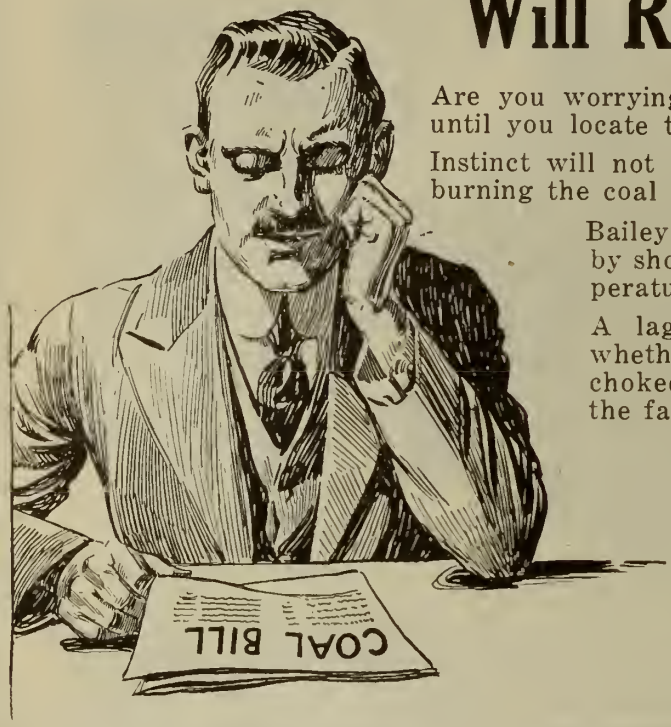
We handle Valves and Regulators for every purpose. Engineers and Power Users are heartily invited to discuss their problems with us. If there is a solution we can solve it.

THE MASON REGULATOR & ENGINEERING CO.,
LIMITED

MONTREAL
135-153 Dagenais St.

TORONTO
145 Wellington St. W.

Bailey Boiler Meters
Will Remove That Worry



Are you worrying over coal leaks? You can't eliminate them until you locate them.

Instinct will not tell your fireman just how well each boiler is burning the coal fed to it. The best they can do is **guess.**

Bailey Boiler Meters will enable them to **know exactly** by showing the steam flow, air flow and flue gas temperature—on the one chart.

A lagging boiler is shown up. The meter tells whether excess air, fouled tubes, broken baffling or choked fires is the cause. There is no guesswork—the facts are right before them all the time.

Write for bulletin.

Bailey Meter Co.

2001 E. 46th Street, Cleveland, Ohio, U.S.A.

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the Celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

Make Your Baffles Gas and Air-Tight and Reduce Fuel Bills

Views above illustrate how easy it is to install baffles with

PLIBRICO JOINTLESS FURNACE LINING

PLIBRICO makes one-piece baffles, having NO joints, which ARE gas-tight and which remain so. PLIBRICO baffles last longer and give better service.

No tiles or blocks to break up, crumble or be dislodged and it is an impossibility for valuable gases to short circuit. Not affected by expansion or contraction.

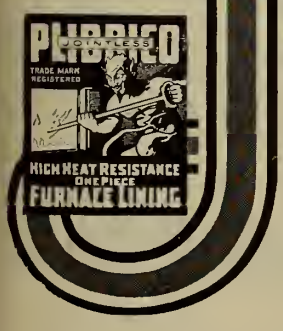
Forms and special tools unnecessary. Any man can apply it.

Try PLIBRICO baffles on one boiler and you will standardize on PLIBRICO on all your boilers, as so many other plants have done. The first installation will quickly prove its great fuel-saving feature.

PLIBRICO is a plastic, easily applied, monolithic furnace lining that may be used to patch up old boiler settings or to put in new settings that last three times as long as ordinary fire brick.

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below. Immediate deliveries from warehouse stocks in principal cities.

Write for book on Furnace Building. Contains valuable diagrams showing modern settings for all types of boilers.

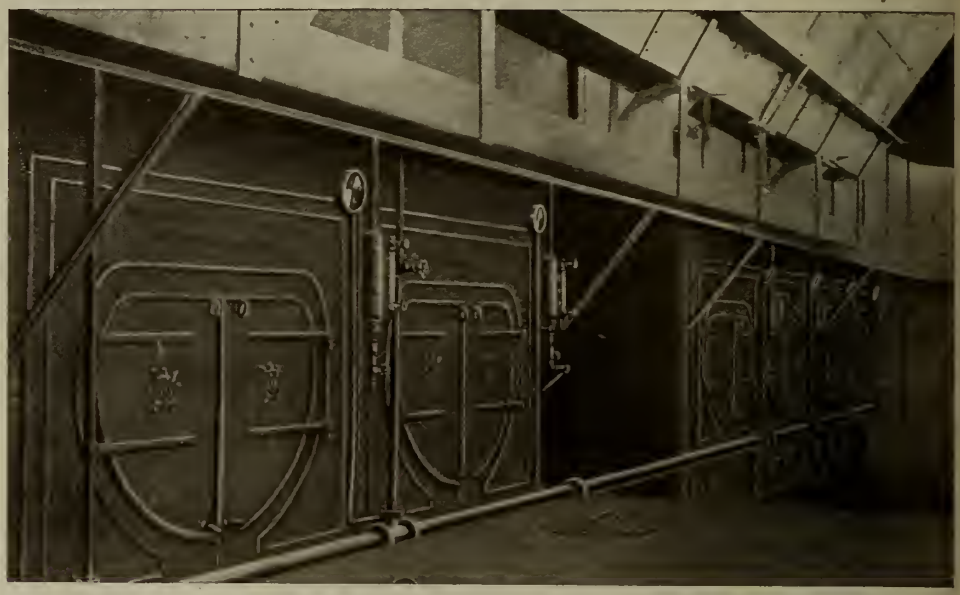


JOINTLESS FIRE BRICK CO.

1130-1150 CLAY ST. CHICAGO.

Buy Your Boiler Now—

With easier money rates and reduced retail stocks the country over, a genuine business revival is just around the corner. We can give that new boiler order good service now.



Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke and Birks Bldg., Montreal

GREEN'S

HI-EFFICIENCY HI-SPEED

RADIAL FLOW FANS

All parts of Green's Radial Flow Fans are easily accessible. Their power consumption is exceedingly low and their sturdy construction assures long wearing qualities.

These are but a few of the many features which recommend Green's fans to careful buyers. Write for our new booklet No. 152; it contains detailed information.

Consult our engineers. They will gladly furnish you complete information with regard to fans to cover your individual requirements.

GREEN'S ECONOMISER, LIMITED.

TORONTO

Republic
CO_2 RECORDERS

Meters that SHOW Where Your Dollars Go

In the Republic the analysis is recorded by a continuous line on the chart. The case complete measures 22x12x5 inches and the entire instrument weighs only 45 pounds.

How Much Coal Did You Burn To-Day?

Do YOU know? And supposing you have an approximate idea of the total fuel consumption, do you know how much of that coal is actually generating power-producing heat? For if combustion is not taking place properly much of that coal which costs so much is going up the smoke stack in gases and heat—utterly useless for power purposes.

You who are so careful in other matters of business—can you afford to go on burning coal regardlessly? Especially when a small sum invested in a Republic CO_2 Recorder will eliminate all waste and put you on the road to **greater fuel economy.**

The Republic CO_2 Recorder is a simple, remarkably accurate apparatus for analyzing flue gases. No other Recorder is so compact and requires so little attention. The Republic CO_2 Recorder has no glass, no delicate parts, nothing to go wrong.

A good CO_2 Recorder is a wise investment. A Republic is your best investment because it saves most. Write for bulletin.

Republic Flow Meters Company of Canada, Limited

Eastern Representatives :
The Mason Regulator & Engineering Co., Ltd.
185 Dagenais St., MONTREAL
Agents for Manitoba and Saskatchewan:
W. W. HICKS & CO., Winnipeg

145 Wellington Street West
TORONTO
Agents for British Columbia:
TAYLOR ENGINEERING CO., LTD., Vancouver

RESULTS OF BOILER TRIAL

PLANT OF Minnesota & Ontario Pulp & Paper Company, Fort Francis, Ontario
OBJECT OF TEST: Economy burning "hog fuel" mill refuse and coal.
CONDUCTED BY: F. J. Lavery, Minnesota & Ontario Pulp & Paper Company.

BOILER: Make Bros. 90" x 20' TYPE: Horz. Ret. Tub. RATED H.P. 325
NO. OF TUBES: 182 SIZE: 3½" WATER HEATING SURFACE: 3414 sq. ft.
STOKERS: Type "A-C" Jones NO. OF RETORTS: 3 (long)

CONDITIONS:	Duration	Hours	4.0
	Steam Pressure	Lbs. Gauge	119.7
	Temperature of Feed Water	Deg. Fahr.	229.0
	" " Escaping Gases	" "	683.0
	Pressure in Air Chamber	Inches	1.6
	Draft in Furnace	"	.05
	" between Damper and Boiler	"	.50
WATER AND FUEL:	Total coal as fired	Lbs.	983
	" "Hog Fuel" fired	Cords	14.4
	" water fed to boiler	Lbs.	77941
	Factor of Evaporation		1.022
	Total Equiv. Evaporation F. & A. 212° F.	"	79656

ANALYSIS:

Coal:

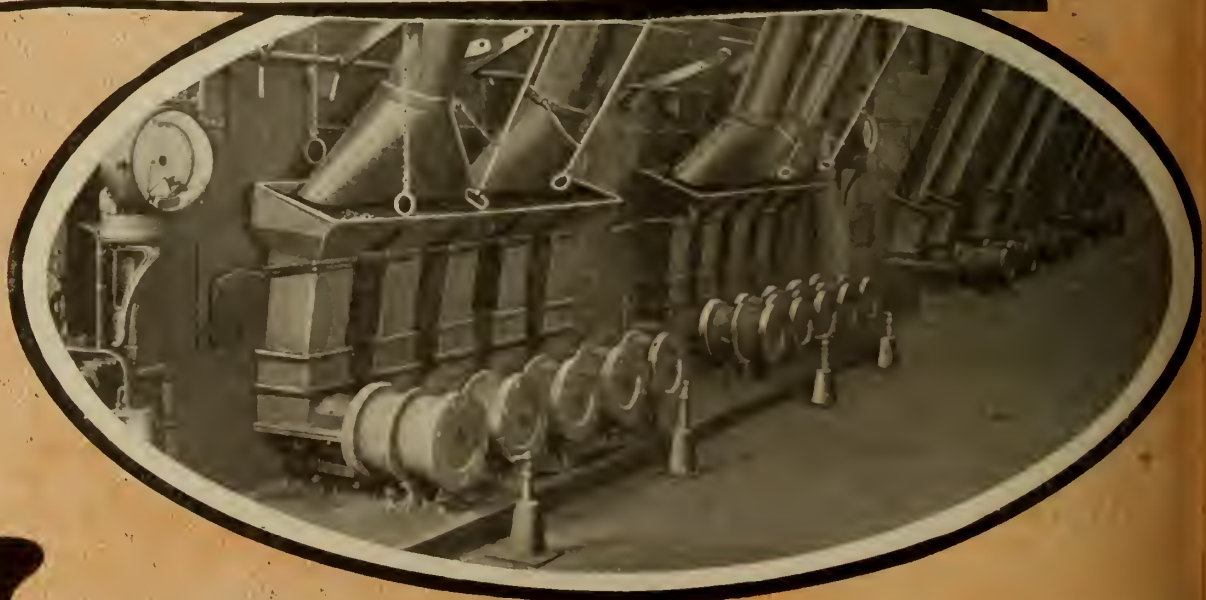
Fixed Carbon	As Fired	Per Cent	48.96
Volatile Matter	" "	" "	36.38
Ash	" "	" "	10.65
Moisture	" "	" "	4.01
Sulphur (Sep. Det.)	" "	" "	3.26
B.T.U. per lb.			12962

Hog Fuel:

Moisture	Per Cent	41.65
Ash, as fired	" "	4.0
B.T.U. per lb. as fired		4220
B.T.U. " " dry		7232
Carbon Dioxide in Flue Gases, per cent		14.8

SUMMARY

Coal burned per hour, as fired	Lbs.	245.5
"Hog Fuel" " "	Cords	3.60
Coal Burned " " per retort, as fired	Lbs.	81.8
"Hog Fuel" " " " "	Cords	1.20
Water Evaporated F. & A. 212° per hour	Lbs.	19914
" " " " " " per sq.ft.htg.surface	"	5.83
Boiler Horse Power Developed (Average)		577.2
Per Cent of Rated Capacity Developed	Per Cent	177.6
Coal Burned per 100 B.H.P. Developed	Lbs.	42.5
"Hog Fuel" burned per 100 B.H.P. Developed	Cords	0.62
Lbs. Water Evaporated F. & A. 212°per lb. coal (Previous Test)		9.27
" " " " " " " " Hog Fuel as fired		2.30
Weight of "Hog Fuel" per Cu. Ft.	Lbs.	16.67



Jones

Results That Can Be Duplicated In Your Plant

Note How Jones "A-C" Stokers Met the Unusual Conditions of this Canadian Plant

The boiler test (opposite) tells more clearly than any amount of description, how efficiently and economically Jones Stokers are meeting the firing requirements of the Fort Frances, Ontario, plant of the Minnesota and Ontario Pulp and Paper Company.

Results like these (they are being duplicated in many Jones equipped plants) emphasize two outstanding advantages of all Jones installations:

(1) The inherent advantages of Jones design.
(2) The engineering service that is a part of every installation.

The basis of the high efficiency of Jones Stokers is the Under-feed principle of combustion, a *Jones* principle, originated and perfected in Jones Stokers.

Heavy Overloads—No Reduction of Efficiency

The fuel, fed by the steam operated ram, is moved mechanically through the long retorts by means of the pusher rods. During its slow travel hydro-carbons are entirely volatilized and completely burned. So the same high combustion efficiency is maintained at high combustion rates as when lighter loads are carried. This is evidenced by the extremely low combustible in the ash even when heavy overloads are carried. The under-feed principle is particularly adapted to burning Canadian coal. Added to the basic advantage of the under-feed principle are:

—*Simplicity,* insuring low maintenance.
—*Automatic control of fuel and air,* insuring even steam pressure regardless of load fluctuations.
—*Automatic-Cleaning,* (in the "A-C" type).
—*Individual control of retorts,* insuring an even fire and high efficiency—and many other distinctive features that adapt the Jones Stoker to every load and every Canadian coal.

Special Firing Problems Solved

Just as Jones engineers met the unusual conditions presented by the Fort Frances Mill where coal and "hog" fuel are burned in combination, they will solve *your* problem—whether a load problem, fuel problem, or labor problem. The engineering service, outlined opposite, is at your command. A survey of your plant implies no obligation.

Few catalogs tell the story of Jones superiority.

Jones Stokers made in two main types: Jones "A-C" (Automatic-Cleaning) high-duty type, and Jones "Standard". Jones engineers will advise which type is best suited to local conditions.

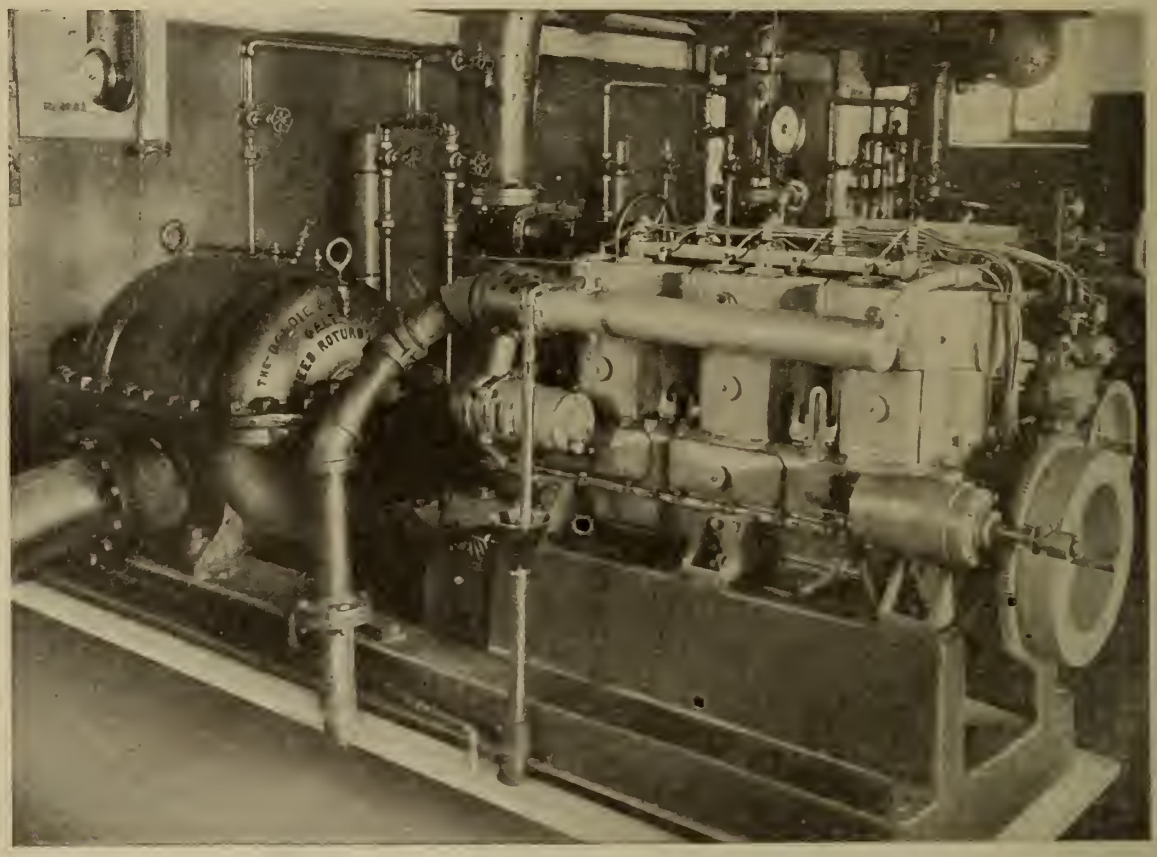
100% Canadian

Jones Stokers are made in Canada by Canadians and sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized and, although the experience and facilities of the older organization are retained, the reorganization also makes available for Canadian power users the extensive engineering resources of the Under-Feed Stoker Co. of America.

The Under-Feed Stoker Co. of Canada
LIMITED
81 Victoria Street, Toronto

Stokers

DEPENDABLE POWER EQUIPMENT



A Gasoline Engine Driven

REES RoTURBo PUMP

Recently installed for Fire Service at the Stratford Waterworks Pumping Station.

Previous to this installation the Stratford Waterworks was equipped with several different makes of Centrifugal Pumps, among them a Rees RoTURBo; it was because of the excellent performance of this pump installed some years ago that the REES was again chosen when additional equipment was required. Rees Pumps are dependable, and their self-regulating, wear-resisting construction make for permanently and highly efficient service over a wide range of duties. Ask for our catalogue and further information.

The Goldie & McCulloch Co., Limited

Head Office and Works: GALT, Ontario, Canada

Branches and Offices:

Toronto Office:
Suite 1101-2 Bank of Hamilton Bldg.

Quebec Agents:
Ross & Greig, 400 St. James St.
Montreal, Que.

Western Branch:
218 McDermott Ave
Winnipeg, Man.

British Columbia Agents:
Robt. Hamilton & Co.
Vancouver, B.C.

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A Series of Articles on Power Plant Management

In This Article the Various Makes of Turbine are Described, Their Operating Features and Comparative Points of Vantage Being Indicated.

By ROBERT JUNE

IT is not a very satisfactory proceeding to attempt a general classification of steam turbines because the various groups overlap to a considerable extent. However, there are sufficient differences in the characteristics of a number of well known turbines so that they may be conveniently classified according to the fundamental principles involved in their operation, as follows:

Impulse				Reaction	Combined Impulse & Reaction
Single Velocity	Multi-Velocity Stage	Single Velocity Stage	Multi-Velocity Stage	Multi-Velocity Stage	Multi-Velocity Stage
De Laval	Terry Sturtevant Curtis (small type) Westinghouse	Kerr De Laval Rateau	Curtis	Westinghouse-Parsons Allis-Chalmers-Parsons	Westinghouse
Single Pressure Stage		Multi-Pressure Stage.			

Impulse Turbines

In turbines of the impulse type the complete expansion takes place in the stationary blades or nozzles and the steam is delivered to the moving blades with a velocity somewhat more than double that of the blades. The velocity of the jet is very high, from 2,000 to 4,000 feet per second, and for satisfactory economy the peripheral velocity of the wheel must also be very high. The passages between the moving blades are of uniform or even slightly increasing cross section from inlet to outlet. The moving blades check and reverse the velocity of the steam current, thus creating a force against the blades which sets the rotor in motion.

If the entire pressure drop takes place in one set of nozzles and the resulting jet is directed against a single wheel, the turbine is classified as belonging to the single stage, single velocity group, of which the DeLaval Class "A" turbine is a well known example.

We have just stated that for satisfactory economy the peripheral velocity of the wheel must be very high in turbines of this sort. However, it is possible to use a lower speed rotor by compounding the velocity. When this is done the jet issuing from the nozzle at a very high velocity is reflected back and forth from the vanes on the rotor to a series of fixed reversing buckets until all the available kinetic energy of the jet has been imparted to the wheel. An excellent illustration of this type of turbine is the Terry single stage machine.

Other means of combining low peripheral velocity and high expansion takes place in a series of successive nozzles instead of one nozzle. Thus, only a fraction of the available heat energy is converted into kinetic energy in each nozzle. For each set of fixed nozzles there is a corresponding rotor. To all intents and purposes this type of turbine consists of a series of single velocity impulse turbines placed side by side.

If we compound both velocity and pressure we have the multivelocity and pressure type of which the Curtis turbine is the best known example.

Reaction Type Turbine

In the reaction turbine, approximately one-half of the expansion in any one stage takes place in the stationary blades, imparting to the steam a velocity substantially equal to that of the moving blades so that it enters them without impulse. The remainder of the expansion takes place in the moving blades, the spaces between which gradually grow smaller from inlet to the exit side of the turbine, thus forming a ring of moving nozzles. The velocity imparted to the steam by reason of the expansion occurring in the moving produces a reactive force on these blades which turns the rotor of the turbine.

Only a very small portion of the heat energy imparts velocity in the first set of fixed blades or nozzles. As the expansion is very gradual a large number of alternate fixed and revolving blades are necessary to effect complete expansion.

Combined Impulse and Reaction Turbines

In multi-stage work it has been found that the use of an impulse element for the first stage of expansion and the use of reaction elements for the subsequent stages forms an effective combination. The impulse element replaces without

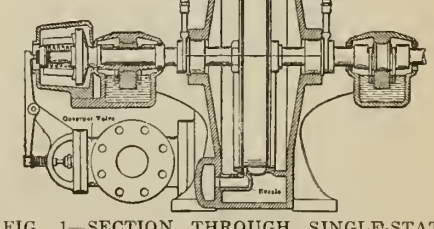


FIG. 1—SECTION THROUGH SINGLE-STATE TERRY STEAM TURBINE.

any appreciable sacrifice of economy a considerable number of rows of reaction blades in the least efficient part of the reaction turbine, and makes possible a shorter, and consequently, stiffer rotor. The Westinghouse-Parsons double

flow high pressure turbine is typical of this class.

Respective Advantages of Impulse and Reaction Turbines

The impulse and the reaction turbines represent two schools of engineering development, each of which secures practically the same result as the other, but by slightly different means. It is fully as difficult to compare the advantages of one type of turbine over the other as it is to compare the respective advantages of horizontal and vertical water tube boilers. While many engineers can offer excellent reason for preferring one type of turbine over the other, the fact remains that to a great majority of engineers these reasons are comparatively unimportant, and their preferences will depend not upon general considerations, but upon the conditions obtaining in their individual plants.

It is plain that in the impulse type, because of the considerable difference in pressure which exists between adjacent stages and the fact that steam leakage increases as the square of the pressure drops, that it is very important that means be devised to minimize the leakage and resultant loss of efficiency. It has, therefore, been the universal practice with this type of turbine to employ a rotor built up of disks mounted on a shaft of small diameter in order that the clearance between the shaft and the diaphragm separating the pressure chambers may be as small as possible. This construction results in a ligh' shaft which may develop deflection seriously. It is also claimed that the disks of the impulse turbine are subject to frequent temperature changes, and because of these changes and the high velocities at which the turbine operates, the disks are to some degree liable to rupture.

An advantage claimed for the impulse turbine is that because the blades are very much larger and very much fewer in number than the reaction blades, that there is considerably less difficulty in maintaining them.

For the reaction turbine it is claimed that the rotor, being made up of a comparatively thin cylindrical drum of considerable diameter with rings of large bore, that the internal strain in the disks is negligible. It has also been said that the drum construction of the rotor makes the reaction turbine very much more accessible for examination and repair.

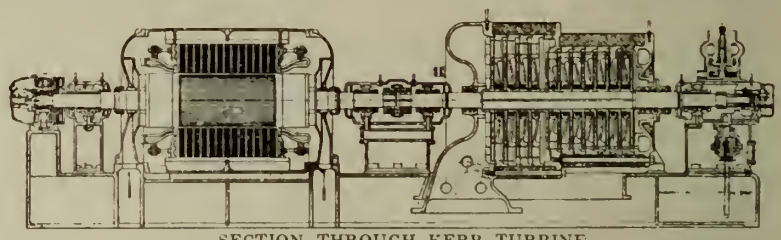
It is well to remember, however, that the several types of turbines are made by concerns of the very highest standing in the engineering world, and this fact may be practically considered as a guarantee of the successful operation of the turbines produced by these manufacturers.

Terry Non-Condensing Turbine

In the Terry non-condensing turbine, Fig.1, courtesy Gebhardt, the compounding the velocity permits of much lower peripheral velocities than with the single-velocity type. The rotor, a single wheel consisting of two steel disks held together by bolts over a steel centre, is fited at its periphery with pressed-steel buckets of semi-circular cross section. The inner surface of the casing is fitted with a series of gun metal reversing buckets arranged in groups, each group being supplied with a separate nozzle. The steam issuing from nozzle N at very high velocity strikes one of the buckets on the wheel, and since the velocity of the buckets is comparatively low, is reversed in direction and directed into the first one of the reversing chambers. The chamber redirects the jet against the wheel, from which it is again deflected; this is repeated four or more times until the available energy has been absorbed by the rotor. Terry turbines are made in a number of sizes varying from 5 to 800 horse power, and operate at speeds varying from 210 feet per second in the smaller machine to 260 feet per second in the larger.

Kerr Turbine

The Kerr turbine, Fig. 2, is of unusual design in that it is built up in sections, the casing comprising a steam end, exhaust end, and whatever number of intermediate stages are best suited to meet the individual condition. The rotor consists of a series of steel disks, mounted on a rigid steel shaft. A series of drog-forged steel buckets is secured to the periphery and riveted in dovetailed slots. The tips of the buckets are riveted to a shroud ring, thereby insuring a rigid and positive spaced construction. The stator is made up of a number of arched cast-iron diaphragms with circular rims tongued and grooved, and bolted to steam-end and exhaust-end castings.



SECTION THROUGH KERR TURBINE.

The operation is as follows: Steam enters the turbine through a double-beat balanced poppet valve, the stem of which is connected through levers to the governor, to the circular cored space extending around the steam "end casting." This space acts as an equalizer and insures uniform admission to the first set of nozzles. Partial expansion takes place through the first set of nozzles and the kinetic energy is imparted to the rotor through the medium of the vanes. Steam leaves the buckets at a very low velocity and is again expanded through the second set of nozzles in the diaphragm. This process is repeated in each stage.

Westinghouse Turbine

In the Westinghouse impulse and reaction turbine, single-flow type, Fig. 3, the substitution of the impulse element for the high-pressure section of reaction blading has essentially no influence on the net efficiency of the turbine. That is to say the efficiency of the impulse wheel is about the same as the least efficient section of reaction blading. This design is attractive, however, in that under some conditions it shortens the machine and gives a stiffer design of rotor.

The entering steam is confined in the nozzle chamber until its pressure and temperature have been materially reduced by expanding through the nozzles. As the nozzle chamber is cast separately from the main cylinder, the temperature and pressure differences to which the cylinder is subjected are correspondingly lessened.

Westinghouse Double-Flow Turbine

The maximum economical capacity of a single-flow turbine is limited by the rotative speed. The economical velocity at which the steam may pass through the blades of the turbine depends on the velocity of the moving blades. The capacity of the turbine depends on the weight of the steam passed per unit of time, which in turn depends on the mean velocity and the height of the blades. For a given rotative speed, the mean diameter of blade ring practicable

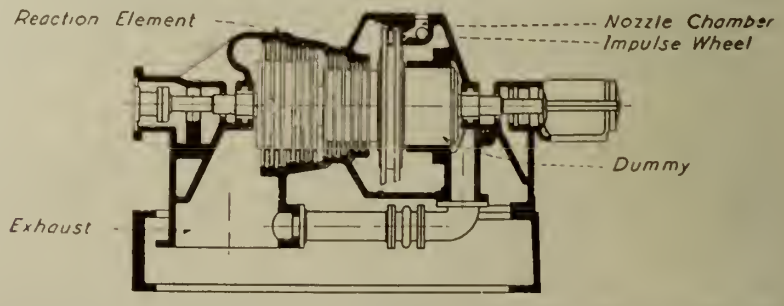


FIG. 3—SECTION OF A COMBINATION IMPULSE AND REACTION SINGLE-FLOW TURBINE.

is limited by the allowable stresses due to centrifugal force, and there is a practical limit for the height of the blades.

Now, if we make the rotative speed only half as great, the maximum diameter of the rotor may be doubled and, without increasing the height of the blades, the capacity of the turbine will be doubled. So with the single-flow steam turbine as well as with the single-crank reciprocating engine, there is a practical limiting economical capacity for any given speed. If this limit is reached with a single-crank reciprocating engine, we may produce a unit of double the power at the same speed by coupling two single-crank engines to one shaft.

The Westinghouse double-flow turbine is in effect, as will be seen from Fig. 4, two single-flow turbines made up in a single rotor in a single casing with a common inlet and two exhausts. Steam enters the nozzle chamber, acts on the impulse element, and then the current divides, one-half of the steam going through the reaction blading at the left of the impulse wheel; the remainder passes over the top of the impulse wheel and through the impulse blading at the right.

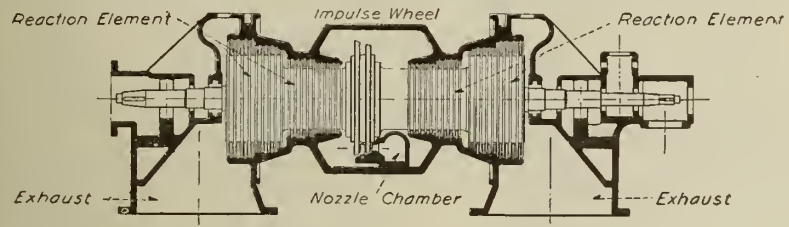


FIG. 4—SECTION OF A DOUBLE-FLOW TURBINE.

Curtis Turbine

All General Electric Curtis turbines, ranging from the very small direct current machines to the huge turbo-alternator of 45,000 k.w., are of the impulse type. So many changes are made in these, as well as in other turbines from year to year, that descriptions can only be given in the most general terms.

In practically all sizes the high-pressure stage comprises a set of nozzles and a single wheel carrying two rows of buckets. Subsequent stages have but one row of buckets on a single wheel, except in the low pressure element of the compound cylinder units where there are two wheels per stage, each with a single row of buckets. The steam flow is axial in all machines.

The speed of the smaller machines is controlled by a centrifugal governor, mounted on the end of the main shaft, which actuates a throttling valve of the balanced poppet valve type.

A relay governor of the hydraulic type controls the large turbo-alternators. Oil is fed to a cylinder under pressure through a pilot valve under control of the main governor. The piston rod of the cylinder contains a rack which meshes with the pinion on a camshaft which in turn lifts the individual control valves as determined by the spacing of the cams.

Bleeder Type Turbine

One of the most interesting developments of the steam turbine is the so-called bleeder or extraction type. Steam is automatically bled from an intermediate stage for heating or manufacturing purposes after it has passed through and done work in the high pressure stages of the turbine. Steam is usually bled at from one to fifteen pounds pressure in quantities from a minimum amount up to throttle capacity of the turbine.

FIG. 5—1000 K.W., 60-CYCLE CURTIS STEAM TURBINE WITH AUTOMATIC STEAM EXTRACTION DEVICE.

It is probably due to the demands of the textile industry more than any other that this type of turbine was developed. The steam so bled is absolutely free from oil and may be used for dye vats, bleaching, slashing, etc., without danger of injury to the product. In conclusion, it has been possible here to describe in rather general terms the principles of operation and the details of construction by which the various turbines differ from each other. For a discussion of the advantages and disadvantages of steam turbines, reference should be made to part 1 of this article, published last month. It seems well in closing to emphasize the fact once more that builders of turbines generally occupy a very high position in the engineering field, and that entire dependence can, as a general proposition, be placed upon the statements and recommendations of the various makers.

OVERCOMING THE HIGH CHARGES FOR HEATING

The annual coal consumption in Canada for domestic purposes is nearly 7,000,000 tons which, if we allow a cost of $15 per ton, represents a yearly expenditure of some $105,000,000. With increasing population and the gradual extension of settlement northerly, this consumption will naturally increase; any effort, therefore, having for its object a substantial reduction in our domestic heating bill, is worthy of public attention.

The hope of relief, entertained by some, through electric heating from our water-powers, has been definitely shattered by the fact that, outside of the question of cost, the demand would far exceed the supply available. For instance, in Quebec and Ontario, alone, assuming a population of some 5,000,000, a total of probably not less than 10,000,000 h.p.—and costing from $150,000,000 to $200,000,000 per annum—would be required to supply electrical heat. The power available within the more thickly populated portion of these two provinces, even including Canada's equity in the great possibilities of the St. Lawrence and Niagara rivers—the greatest water-power rivers in the world—only amounts to about 5½ million horse power.

The possibilities and economic efficiency of central heating plants appear particularly applicable to Canadian conditions or to any country with long winters. Due to the initial cost of the underground distribution piping system, the plants usually involve heavy overhead expenses; when the plant is used intensively and during long periods each year, the charges can be spread over longer periods than would be the case for systems only used during shorter periods, as in certain localities in the United States. Another economy would result from the possibility of using the cheaper grades of coal, instead of the expensive anthracite now commonly used in Eastern Canada. Suitable boilers with automatic stokers and smoke-consumers would overcome some of the present disabilities in the use of the inferior fuels.

—L. G. Denis.

A Disastrous Fly Wheel Explosion

NOT long ago one man was killed and two others were injured by being struck by fragments from a flywheel which exploded in a sawmill and hardwood-floor factory. The engine was of the Corliss type and was belted to an electric generator which supplied current for operating the machines in the factory. The flywheel was 18 feet in diameter, with a face about 36 inches wide, and was operated at a speed of about 92 revolutions per minute.

THE DAMAGED ROOF OF THE FLOORING FACTORY.

The accident occurred soon after starting-up time in the morning. The engine-room was totally wrecked, and bricks and pieces of broken flywheel were thrown in all directions. One of the spokes of the flywheel was thrown into the air and came down through the roof of the sawmill about 150 feet distant. It struck a man who was working there and killed him instantly.

A large piece of the rim crashed through the roof of the flooring factory near by, struck an edger table, and tipped over upon the concrete floor. Three workmen were close by the machine at the time, but fortunately escaped injury. Still another large fragment was thrown into the air and after travelling several hundred feet buried itself deep in the ground. The illustrations herewith will give some idea of the conditions after the accident.

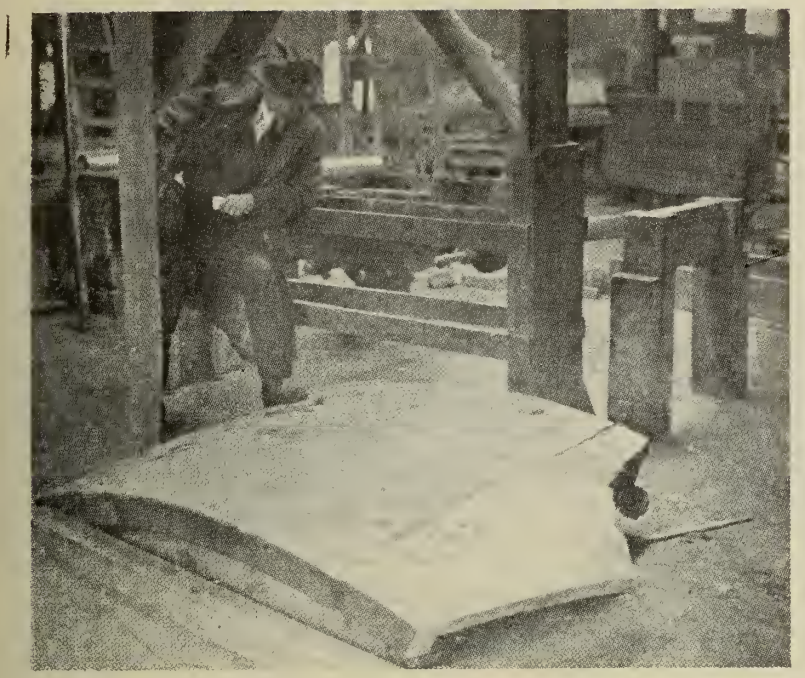
The extensive property damage which resulted from this explosion, and the distance to which large sections of the burst flywheel were carried, appear to indicate that the wheel burst from overspeed. We do not know what cause, if any, has been assigned for the failure of this particular wheel, but it may be interesting and profitable to discuss the bursting of flywheels in general, in order to direct attention to some essential features of safe engine-operation.

One of the commonest causes of flywheel explosions that occur in consequence of overspeeding is the failure of the governing apparatus. In the case of a belt-driven governor the belt may break or slip, or come off the pulley on which it runs, or the key or set-screw which secures this pulley to the shaft may work loose or drop out. If any of these things should happen the governor would become inoperative and the engine would be likely to run away. A similar result might follow the disarrangement of the mechanism of a shaft-driven governor or of a governor of the centrifugal type.

It is vitally important, therefore, to inspect the entire governing mechanism frequently and thoroughly, and to make sure that it is in good working order at all times. The belts of belt-driven governors should be kept at the proper tension and free from oil and grease, which would cause them to slip. The key or set-screw that secures the governor pulley to its shaft should be kept tight, and the gears of gear-driven governors should be kept well lubricated and in good condition in every other respect.

For greater security, a governor safety-stop should be provided in connection with each fly-ball governor. This may be operated electrically or mechanically, and should be arranged so that when the governor rod descends to a dangerously low position (in consequence, for example, of the breaking of the governor belt), a spring or some other equivalent device will be released, which will close the steam-admission valve and stop the engine. A safety-device of another form consists in an idler pulley, which rests on the governor

THE REMAINS OF THE FLYWHEEL.



A SECTION OF THE BROKEN FLYWHEEL RIM.

belt under ordinary circumstances, and is connected to a quick-closing valve in such a way that the steam will be shut off if the belt breaks and allows the idler pulley to drop.

In connection with machines (such as large engines), which are capable of producing so much harm in case anything goes wrong, it is desirable to take every reasonable precaution to prevent accidents. It is therefore advisable to provide, in addition to the ordinary governor, an automatic speed-limiting device which is designed to limit the speed of the engine independently of the governor. A number of different devices of this kind are available, which are of proved value. Some of them are more or less complicated in design and construction and require careful mechanical adjustment, and some of them are operated electrically. Every such device should receive proper care, and the instructions of the manufacturers with regard to installation and maintenance should be rigidly followed. It should also be tested frequently and regularly, and the character of the tests should be such as to leave no doubt with regard to the positive and effective operation of the entire apparatus.

Other possible causes of overspeeding in connection with accidents such as the one under discussion are the breaking of the main driving belt and the sudden removal of the load on the engine due to failure of the electric generator that the engine is driving. In either case the prompt and effective action of the governing and controlling devices must be depended on to prevent disaster.

There appears to be an unfortunate tendency on the part of many persons to place too much reliance on automatic safety devices and to feel that the mere installation of them is sufficient to secure all the benefits and advantages that such apparatus is intended to provide. These persons are likely to become careless in performing certain duties that are absolutely essential for safety in the absence of automatic devices, and to either carry these duties out perfunctorily or to omit them altogether. Eventual disaster may reasonably be expected if this state of mind is allowed to persist, because any mechanical or electrical device, however nearly perfect it may be, may fail to operate at a critical time, through no fault of the designer or manufacturer of it. Even though material safeguards of the most approved type are in place, personal vigilance should never be relaxed for a moment, nor should any precaution ever be omitted which tends to insure the safety of life or property.

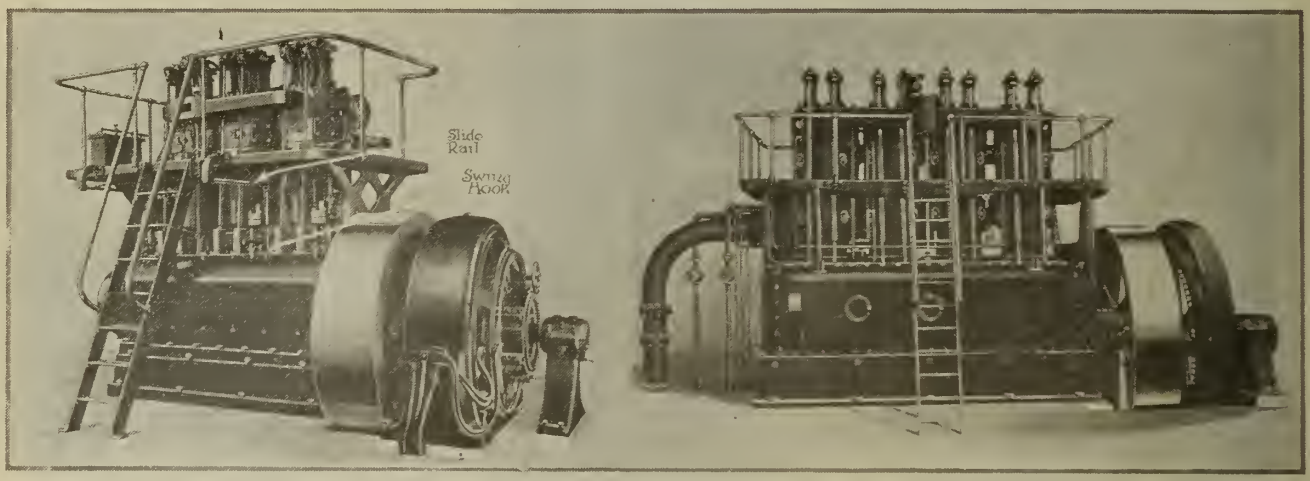
MOLYBDENUM IN STEEL MAKING

A prominent American metallurgist states that ferromolybdenum is added in a fixed condition. It is supposed to give the steel properties similar to those of tungsten steel, but only one-third to one-half as much molybdenum is necessary; that where regular, high-speed steel contains 18 per cent. tungsten, 6 to 9 per cent. of molybdenum may be substituted. However, it gives these properties only when the addition is properly made and proper heat treatment follows. The regulation of these factors caused so much trouble and expense that, in the United States, the manufacture of molybdenum high-speed tool steels has been practically discontinued for several years. It is used for this purpose in other countries, however, to a considerable extent. At the present time it is mainly employed in tool steel as an auxiliary rather than as a major constituent. Various reasons have been assigned for the discontinuance of the use of molybdenum.

An experiment in paving is being carried out on the Victoria Bridge across the St. Lawrence at Montreal, and if the method of paving is successful, the entire length of the bridge will be completed next year. Two hundred feet of mastic flooring are being laid, with the object of determining how well it will withstand the weather during the winter. One advantage claimed for the material is that it is fireproof, and will prevent such disasters as the starting of fires caused by the overheating of gasoline and oil from passing automobiles.

GENERAL VIEW OF WRECKED ENGINE ROOM.

A New Development of the Heavy Oil Engine



By F. A. McLean, Canadian Ingersoll-Rand Co.

FOR power plant service the advantages obtainable from the use of oil engines are briefly: simplification of equipment, a reduction in labor charges, the elimination of standby losses, a saving of space—due to the absence of boilers and accessory equipment—and a simpler and more convenient fuelling problem, representing in their entirety a much lower cost for power output.

Plant owners and engineers have paid close attention to the story of oil engine development, which within the last few years has been one of gradual transition from the Stuart or Diesel type, with its well-known high fuel economy, but poor flexibility in starting and stopping, and necessity for operating on high temperatures and at high pressures, with consequent trouble, due to the inability of the metals obtainable to stand the severity of the service.

Following this came the development of the so-called Semi-Diesel type, which eliminated some of the complications of the earlier type, but introduced others that are equally undesirable. In comparison with the Diesel type it has a much lower operating economy; consumes more lubricating oil; is difficult to start, and requires the use of a blow torch for the preliminary heating of a hot plate, cap or bulb, for ignition purposes.

Numerous attempts have been made by different designers to overcome the objectionable features of both the Diesel and the Semi-Diesel types and to develop a low compression engine possessing high operating economy.

The Ingersoll-Rand Company along with others entered this field, made an extensive study of heavy oil engines and, as a result of their researches and experiments, recently placed on the market a line of stationary and marine oil engines of a distinctly new type.

These new engines are different from any other oil engine on the market, being neither of the Diesel nor Semi-Diesel type, although it is asserted that they possess the advantages of each type with none of their disadvantages. They are known as the Ingersoll-Rand, Price Rathbun type, heavy oil engines, and operate with highest economy on a new principle, which permits their simplification to a remarkable degree. Engineers who are familiar with the extreme simplicity of the ordinary gas engine, can well appreciate what has been done in this line.

In the past, heavy oil engines of high economy have operated on cylinder compressions of between 500 and 600 pounds air pressures of approximately 1,000 pounds per square inch being used for the injection of fuel, thus requiring the use of a two or three stage air compressor attached to the engine itself, or separately driven. In either case the power required to operate them amounted to at least 10 per cent. of the total power output and they required considerable attention on the part of the operating force. All this troublesome and inefficient air injection equipment has been eliminated in this new engine, and it has demonstrated some things heretofore considered impossible.

In a rigid 72-hour test conducted a few months ago a three-cylinder engine built for central station service in Cuba showed at full load an average fuel consumption of 0.425 pounds of fuel per brake horse-power hour, with a compression pressure of less than 200 lbs. per square inch. At three-quarters load the average fuel consumption was 0.45 lbs. and at half load 0.51 lbs., the oil used being of 28° Baume. In considering the fuel economy of this engine (approximately 0.4 lbs. per brake horse-power hour), it is interesting to remember that in marine practice it has been customary to give fuel economies on the basis of indicated horse-power, and inasmuch as the mechanical efficiency of a Diesel engine is about 75 per cent., 0.4 of a pound per brake horse-power is equivalent to 0.30 lbs. per indicated horse-power hour for the Diesel engine.

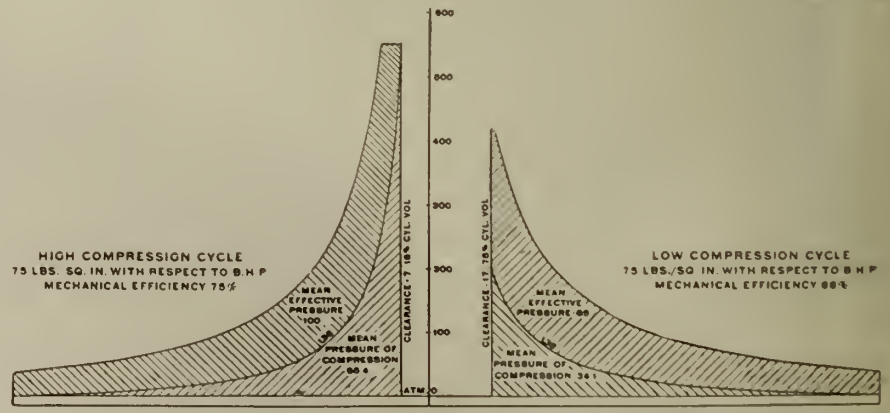


FIG. 1—DIAGRAM ILLUSTRATING MARKED DIFFERENCE BETWEEN HIGH AND LOW COMPRESSION CYCLE.

In other words, the Diesel engine would have to operate at 0.30 lbs. per indicated horse-power hour to equal the figures given for the new engine.

Cycle of Operation

The engine operates on the four-stroke cycle, with low compression (approximately 200 lbs. per square inch), with direct fuel, or as it is sometimes termed, solid fuel injection, and is absolutely independent of hot tubes, bulbs, caps and starting torches, nor is it a surface ignition engine.

The inlet valve is opened mechanically and the piston travels downwards on the suction stroke, drawing in a full charge of pure air. The intake valve is closed by its spring and the piston returns, forcing the air from the cylinder into the combustion chamber and compressing it to a pressure of approximately 200 pounds per square inch.

Injection of fuel starts near the end of the compression stroke and is completed before the piston reaches the end of its travel. Perfect working stroke combustion at constant volume occurs almost exactly at dead centre, the pressure rises from 200 to approximately 400 lbs. and the piston moves downward on the working stroke.

Near the end of the working stroke the exhaust valve is opened mechanically, the pressure drops, and the piston expels the burnt charge on its return.

Various Cycles

The cycle of this new P. R. engine is closely related to that of the ordinary four-cycle or automobile engine, and the marked difference between this cycle and that of engines of the high compression type is clearly indicated by Figure 1, while comparative indicator cards for the Diesel, the Ingersoll-Rand, and a Corliss engine are shown in Figure 2. It will be noted that the cycle of the new engine falls in between the Diesel and Corliss engine cycle. The ratio between the amount of work delivered by the engine and the amount of work done in the engine cylinder during the compression and expansion strokes is 35 per cent. for the Diesel, 49 per cent. for the Ingersoll-Rand, and 75 per cent. for the steam engine. This ratio may be called "The co-efficient of durability" or "power factor" in the same sense as the expression is used in electrical computations. An alternator which has a power factor of 75 per cent. is performing within itself 100 units of power, of which 75 units are available for use. The life of an engine, the cost of lubricating oil, repairs and attendance required is indicated by this power factor or "co-efficient of durability." In other words we have the Corliss with a high power factor of 75 per cent. lasting for very long periods and requiring very little lubricant, repairs or attention. Next comes the new engine with its power factor of 49 per cent. indicating that it will last 40 per cent. longer and require correspondingly less lubricant and attention than the other, with its 35 per cent. power factor.

Advantages of Low Compression Cycle

In the Ingersoll-Rand cycle, as already mentioned, the compression is carried to approximately 200 lbs., when combustion at constant volume occurs, raising the pressure to about 400 lbs., at which point almost perfect adiabatic expansion begins. In the high compression type the pressure is carried about 500 lbs. and oil is admitted gradually, so as to produce combustion at constant pressure until the piston has travelled a portion of its stroke, from which point expansion begins. Thus there are four points of particular advantage in the low compression cycle.

First, a lower ignition temperature is required, due to the elimination of the refrigeration action of the injection of air in the Diesel engine, as it expands from 1,000 pounds per square inch down to the cylinder compression pressure. Second, the engine we are discussing does not require an air compressor for fuel injection, friction losses are lower, and—due to its higher mechanical efficiency—the mean effective pressure which is proportional to the net work developed in the engine cylinder for the same brake horse-power of engine need only be 85 per cent. of that of the high compression cycle.

The mean pressure of compression which is proportional to the work done in the engine cylinder during the compression stroke is approximately half that of the high compression cycle, and although it is true that this work is not lost, but returned to the piston during the expansion stroke, nevertheless the performance of this extra work of compression by the piston and the return to the latter of an equal amount of excess work during the expansion strike represents considerably more wear on the piston, cylinder and bearings. For equal brake horse-power the low compression cycle subjects the engine to about 30 per cent. less wear. Parts of equal dimensions will therefore wear considerably longer and require much less attention.

As previously mentioned, the new engine is free from hot caps, tubes, bulbs, uncooled apron castings, etc., an electric igniter being used for the first few ignitions when "starting cold." The absence of hot caps or hot surfaces of any kind is of great advantage in eliminating overheating troubles at full load and underheating troubles at light loads. As there are no highly heated parts, a full charge of air can be drawn in, instead of heated, expanded, and reduced in volume. This is one of the ways in which the higher power attained with this engine for a given piston displacement may be accounted for. The splitting of hot caps is eliminated, the absence of starting torches reduces the fire hazard, and tends to make a cleaner and cooler engine room. The engine being comparatively cool at all points, the operator is enabled to attend to it with greater ease.

Fuel Supply and Injection

A pump driven from the engine elevates the oil from the main supply to a filter of special construction located at one end of the platform from which the oil is fed to the fuel injection pumps by gravity. The fuel injection pumps, one for each cylinder, are mounted on the housing near the cylinders and operated by cams from the side shaft, which also drives the centrifugal governor used to control the amount of fuel injected and vary the intake of air so as to maintain

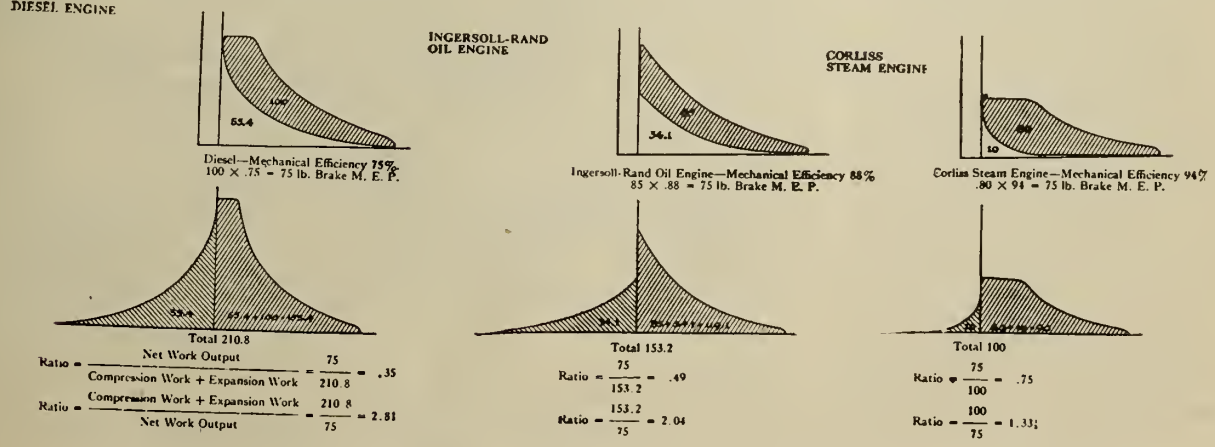

DIESEL ENGINE
INGERSOLL-RAND OIL ENGINE
CORLISS STEAM ENGINE
Diesel—Mechanical Efficiency 75%
100 × .75 = 75 lb. Brake M. E. P.
Ingersoll-Rand Oil Engine—Mechanical Efficiency 88%
85 × .88 = 75 lb. Brake M. E. P.
Corliss Steam Engine—Mechanical Efficiency 94%
.80 × 94 = 75 lb. Mean Effective Pressure
Total 210.8
Ratio = Net Work Output / (Compression Work + Expansion Work) = 75 / 210.8 = .35
Ratio = (Compression Work + Expansion Work) / Net Work Output = 210.8 / 75 = 2.81
Total 153.2
Ratio = 75 / 153.2 = .49
Ratio = 153.2 / 75 = 2.04
Total 100
Ratio = 75 / 100 = .75
Ratio = 100 / 75 = 1.33

FIG. 2—CHARACTERISTICS OF DIESEL, INGERSOLL-RAND AND CORLISS ENGINE CYCLES COMPARED.

the cylinder temperature under various loads.

Fuel is injected by the fuel pumps without the use of air injection equipment and the economy is said to be just as high, or even higher, than that of the most complicated air injection engine.

The question that will naturally be asked is this: How does the engine operate without injection air? The answer is simple: The fuel injection system used reduces the fuel to such extremely small particles that a tremendous amount of oil surface is exposed to the action of the increasing temperature obtained during the latter part of the compression stroke. The fuel injection system thus pulverizes the fuel to a "fog cloud" and at the same time obviates the impingement of the oil upon the walls of the combustion chamber.

So perfect is the "fog cloud" formed that it has been found possible to inject the oil with the engine at rest, allow the fog cloud to dissipate and then demonstrate that the walls of the chamber were perfectly dry. The fuel sprays are located at diametrically opposite points on the combustion chamber, so that they are not only balanced against each other, but the resulting motion of the "fog cloud" after impact is opposed by the air coming up through the passage from the cylinder to the combustion chamber, as will be noted by referring to Figure 3. Injection of the fuel begins about 40 degrees before compression dead centre and ends about 10 degrees before compression dead centre.

High Fuel Economy

A statement that one sometimes hears from those who do not realize that economy and dependability are intimately related is that, since the fuel cost of an oil engine is so low, a gain in economy is a small factor, dependability being the principal requisite. Every heat unit in the fuel, however, that is not transformed into useful work must be dissipated in some way. Either through the walls of the combustion chamber or through the cylinder walls to the water in the jacket, or else it is carried past the exhaust valve and its seat during exhaust, or it may disappear as friction in the bearings or cylinders with consequent bad effect on the upkeep and durability of the engine.

If the engine is inefficient, not only is a large percentage of useful fuel wasted, but in getting rid of the waste heat more or less rapid deterioration results. The waste oil must be added to the fuel bill, or paid for in additional lubricating oil required to preserve the oil film on the overheated piston and cylinder walls; or else paid for in the increased amount of cooling water required to dissipate the waste heat and ultimately in engine upkeep. High fuel economy means, therefore, low fuel cost, low lubrication cost, low cost of cooling water, lower cost of repairs and longer engine life.

It is perhaps needless to say that when an oil engine operates at such high economy as does the type described, no carbon will be deposited in the cylinder and that the exhaust will be practically colorless. The cylinders of these engines after long periods of continuous operation are said to look as clean and bright inside as do the cylinders of a high-grade steam engine, and the piston and rings also remain bright and free.

General Description

The Ingersoll-Rand "P.R." stationary oil engine is of the vertical multi-cylinder, single acting, four cycle type and is offered for general power plant service for either belt or direct connection to alternators, direct current generators, or other classes of machinery. It is said to be especially suitable for driving alternating current generators in parallel and is built at present in seven sizes, with capacities of 105 to 480 brake horse-power. It consists essentially of a heavy base or bed plate, to which is bolted a housing carrying the cylinders with their heads, manifolds and fuel injection pumps.

Base and Housing

The bed plate is of heavy construction and simple design, cast so as to form a reservoir for the lubricating system. Ribs and broad flanges give rigidity and ample bearing on the foundation. The crank shaft bearing pedestals are also cast integral with the base, as can be noted by referring to Figure 4. The housing which encloses the driving parts and forms the top half of the oil reservoir is a strong ribbed casting provided with ample means for gaining access to the interior. Doors placed at the back directly opposite the crank throws permit easy inspection or adjustment of the driving parts, while a single cover bolted to the front of the engine and supported on swinging hooks, trolleys and slide rails suspended from the platform, permits access to the side shaft, governor, eccentrics, etc. This arrangement is shown in Figure 5. Working stresses in the housing are eliminated by the use of stay bolts or tie rods, which transmit the working stresses from the top of the housing to the bed plate.

Main Bearings

Four bearings are used on the three cylinder engine and five on the four cylinder size, and as there is perhaps no other one feature in the design of the vertical multi-cylinder oil engine that has more to do with its mechanical upkeep, the main bearings of the engine have been designed along lines which ensure true and permanent alignment, and provide for quick and easy adjustment. As shown in Figure 4, the bear-

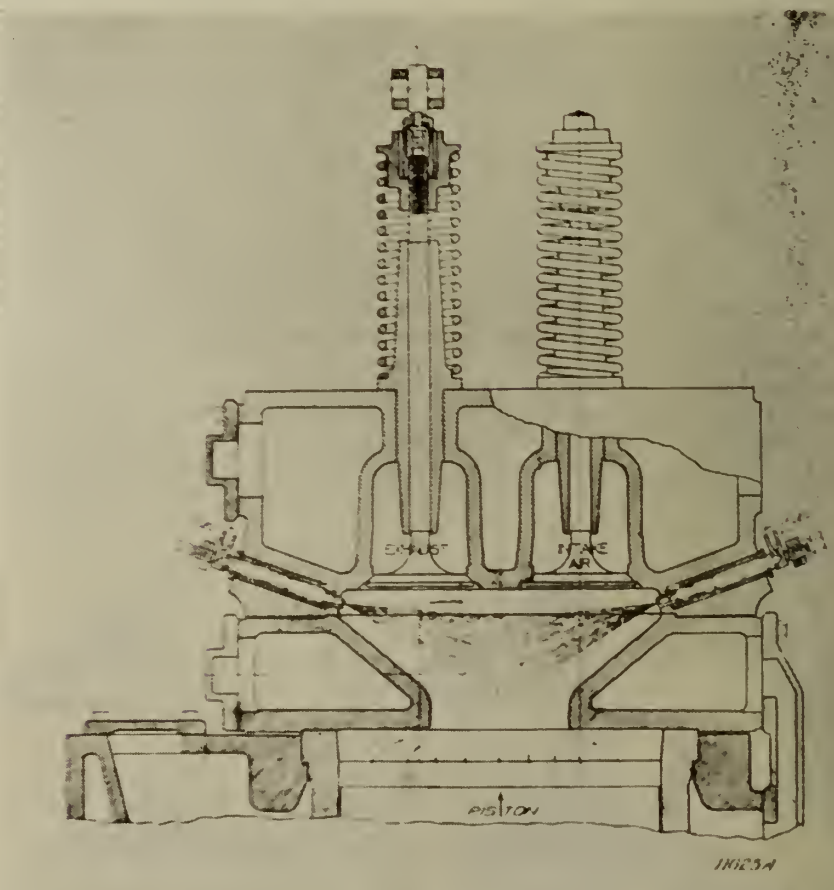


FIG. 3—CROSS SECTION OF COMBUSTION CHAMBER SHOWING LOCATION OF FUEL INJECTION NOZZLES AND MOTION OF FOG CLOUD.

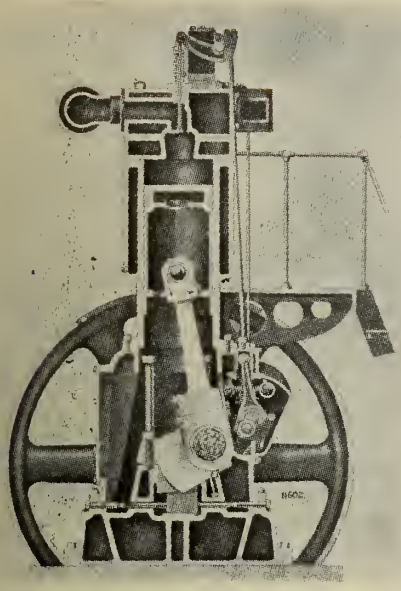


FIG. 4 CROSS SECTION OF P. R. STATIONARY OIL ENGINE.

ing caps are bolted securely to the bed plate; the bottom halves are held rigidly sidewise in the bed plate and supported on wedges which are adjustable from the outside by wedge bolts. By shifting the wedges the bottom half of each bearing may be raised until the shaft is brought into contact with the firmly held bearing caps, securing perfect alignment. The wedge bolts are then tightened and prevent further movement. By removing the wedge and bolts any one of the lower bearing caps can be taken out and renewed without disturbing the other parts of the engine.

Cylinders and Heads

The cylinders are semi-steel castings, well water jacketed and supplied with conveniently located clean-out holes. The cylinder and cylinder head water jackets are connected by outside manifolds in place of the more usual jacket to jacket connection. This permits the use of metal to metal joints and eliminates troublesome gaskets and packing at points of high pressure.

Cylinder heads are in two parts, the intermediate head forming the combustion chamber and carrying the compressed air starting valve and starting element and the main head, containing fuel injection, nozzles, air inlet and exhaust passages and valves.

Pistons

The pistons are cast from a special material designed to withstand wear and avoid warping. They are carefully finished and fitted with a "fire" ring near the top, three beveled rings held by bevelled segments and flat springs near the middle and a wiper ring in the skirt. The latter prevents an excess of crank case oil entering the cylinders, or used cylinder oil entering the crank case. Surplus lubricating oil in the cylinder is conveyed to a separator and vented to the atmosphere.

Valves and Valve Motion

Valves are of the poppet type located in the head, as previously mentioned and are operated through a valve motion known as the "roller path type" from eccentrics mounted on the side shaft. Timing of the valves and fuel injection is obtained from this side shaft through the medium of a pair of spur gears driven by the crank shaft and the entire valve motion and timing mechanism works smoothly and quietly.

Crank Shaft and Connecting Rods

A solid one-piece steel forging is used for the crankshaft, ensuring uniform strength and stiffness. The connecting rods are forged from mild steel with a solid eye and adjustable bronze box at the wrist pin and a babbitted steel half box and a babbitted steel strap bolted and keyed to the rod at the crank pin end.

The Fly Wheel

The flywheel is of the split hub type, massively constructed and acts as a strong and rigid coupling between the main shaft and the extension shaft, the dimensions of which vary according to the requirements of each installation. A self-aligning outboard bearing provides additional support for the extension shaft.

Lubrication

As previously mentioned, the bed plate and housing are arranged to form a reservoir for the automatic lubrication system. Adjustable dippers on the connecting rods dip into the oil at each revolution and drench the working parts with oil. Troughs on the inside of the housing catch part of the oil and convey it through pipes to the main bearings. In operation, oil from an elevated filter is supplied to the main bearings through open sight feed oilers, insuring a constant supply while the engine is running. The oil level in the base is adjustable and the overflow is returned to the filter by a small pump.

Starting

Electric ignition—by means of a small element in the combustion chamber, heated to a dull red—is employed for the first few revolutions, when the engine is absolutely cold, while compressed air from a tank under pressure of 150 pounds is admitted to each cylinder in succession by means of mechanically operated starting valves and serves to turn the engine over. As the engine is turned over fuel is injected and after a few revolutions the air and ignition are cut off and the engine continues to ignite entirely by compression. Where compressed air and electricity are not available for starting purposes they are usually provided by a small gasoline or kerosene oil-driven compresser and a belted generator.

T. W. Lesage, for eleven years superintendent of the Montreal Waterworks Department, will resign from the city service at the close of the year. Mr. Lesage entered the service of the city thirty-three years ago, and his start was in charge of construction work. In 1890 he was appointed assistant engineer to the city surveyor. In 1900 he was transferred to the waterworks department, taking the position of assistant superintendent. In 1911 he succeeded Major Georges Janin as superintendent. A year ago he was superseded by Supt. Terrault, and for the past twelve months Mr. Lesage has acted in the capacity of consulting engineer for the city.

NEW FUEL

A new compound fuel, named thermalene, has been produced by Karl Wolf, of Zurich. It is a mixture of acetylene and vaporized oils, and is claimed to have important advantages over other gases as a fuel for high temperatures. As now manufactured, the generating mixture, consisting of alternate layers of calcium carbide and crude oil absorbed in sawdust, is packed in tin cans, the largest yielding 200 cubic feet of gas. The addition of water liberates the acetylene, and the heat of the reaction converts the oil into vapor. The two gases are cooled and purified, ready for use in the pipes. The gas mixture is not corrosive or poisonous, has an inoffensive odor and is not liable to cause explosions. At normal temperature, thermalene, which is somewhat heavier than air, is liquefied by a pressure of 1,500 pounds or 1,600 pounds per square inch.

BENDING PIPE

Bending pipe is by no means a simple task. There is always a right and a wrong method. In bending large pipe you should fill the pipe with dry sand and plug the ends. Heat to a red heat in localities to be bent, then bend. Be sure that the sand is dry. Where bends are slight it is often unnecessary to use sand or rosin. The object of sand or rosin is simply to keep the sides of the pipe from collapsing, or, to prevent reduction of flow area. If wet sand is used, and if the ends are plugged, the pipe may burst when heated, due to the steam pressure generated.

Rosin is also good. But there is a "right way" and possibly several wrong ways to use it. For example: A mechanic was recently bending a pipe, and he first of all filled the pipe with rosin, plugged the ends, and heated the pipe at the place where he wanted to bend it. He watched for a "red heat" just as he would had he filled the pipe with sand. The result was of course a violent explosion.

The correct way to use rosin is to pour it into the pipe and allow it to cool and harden. As soon as the rosin is hard, bend the pipe cold. Don't heat it. Then after the pipe is bent, heat the pipe all over sufficiently to melt and remove the rosin.

A Course of Instruction For the Graded Certificate

This Instalment Deals With the Effect of the Angularity of the Connecting Rod on Steam Distribution, and Introduces the Subject of Valve Diagrams

By T. H. FENNER

IN the last lecture it was shown how the positions of the valve, eccentric, crank and piston were related during the stroke of the piston. There is one point to observe in this connection. With the ordinary length of connecting rod it is not possible to get equal distribution of steam at each end of the cylinder unless special provision is made for it.

Angularity of Connecting Rod

The effect of the obliquity of the connecting rod, or to make it clear, the angle the rod makes with the centre line of engine, is to change the relative position of valve and piston at certain points of the stroke. If the connecting rod were always of sufficient length to be practically parallel to the centre line of engine this would not take place. If the eccentric rod was of the same length in proportion to the eccentric as the connecting rod is to the crank the effect would be neutralized. However, neither of these conditions occurs in actual practice.

The connecting rod is generally from 2 to 2½ times the length of the stroke, or 4 to 5 times the length of the crank. The eccentric rod is so long in respect to the eccentric that the rod is practically always parallel to the centre line of the engine.

The angularity of the connecting rod causes the piston and crank to differ in their relative positions at certain parts of the stroke, but the eccentric always remains in the same position relative to the crank. As the eccentric rod is long enough to keep the valve always coincident in position to the stroke of the eccentric, it can readily be seen that the valve will be out of relation to the piston when the piston is out of step with the crank. The particular result is to cause steam to be cut off earlier on the inward stroke of the piston than on the outer. To overcome this, it is usual to give the valve more lead on the crank end than on the head end, when the valve is made with equal steam laps at each end. The same result can be achieved by giving the valve the same lead but less amount of steam lap at the crank end. This will be shown more plainly when we consider the valve diagrams.

This subject of the connecting rod and its effects has often been very troublesome to the student. We will try to make it perfectly clear by means of the following diagrams.

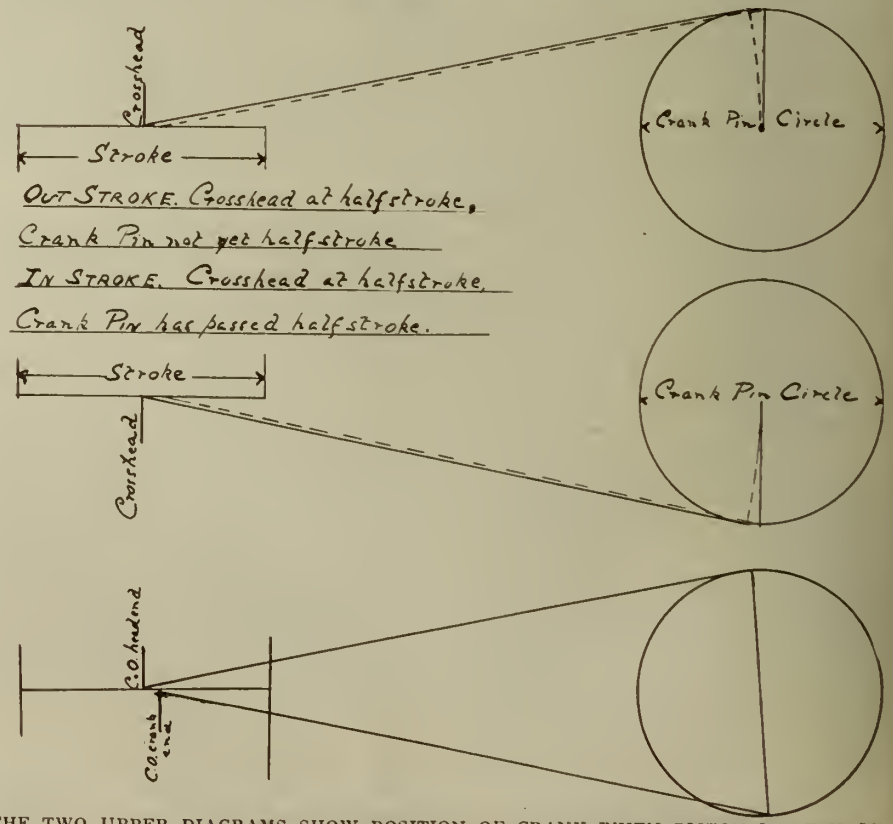
The stroke is 2 inches and the connecting rod 5 inches. On the outstroke the crosshead and therefore the piston has reached half stroke before the crank has turned through 90 degrees. When the crank is at 90 degrees the piston is more than half stroke. On the inward stroke, when the crank has turned through 90 degrees, the piston is not yet at half stroke, and only after the crank has turned a little distance past the 90 degrees does the piston reach its mid position. A little thought will show what effect this will have on the steam distribution. Let us suppose that we have arranged for this engine to cut off at half stroke. On the out stroke the crank will be just short of the half stroke when steam is cut off but the piston will be at exactly half stroke. Now if we have equal lap and lead on the valve, cut off at the crank end will take place when the crank has moved through 180 degrees from the head end cut off position. It will be readily seen from the lower diagram that the piston will not have reached half stroke. It is in order to counteract this effect that the valve is set with more lead on the crank end than the head end, thus making the cut off later, and giving more nearly equal steam distribution.

Valve Diagrams

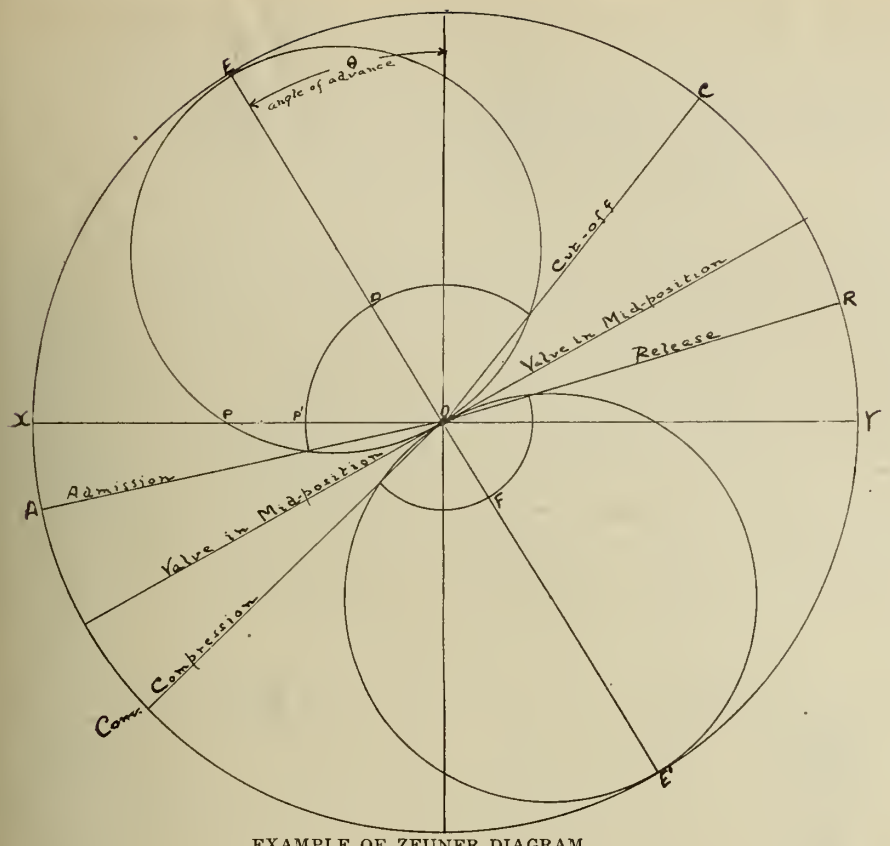
In order to give more information and in an easy way, several diagrams have been evolved which give the position of the valve at a glance, or from which the various points can be determined. The most popular of these is the Zeuner, and it is a very useful and convenient thing to study valve motion from.

To construct a Zeuner diagram, describe a circle to represent the path of the eccentric and also the path of the crank pin on a smaller scale. That is, the same circle represents the two travels, eccentric and crank. Assume a certain angle of advance, and lay this off from the centre line towards the crank. Be clear on this. The angular advance is laid off towards the crank in the diagram, although it is of course away from the crank in the engine. Draw a line from the centre of the circle to join the circumference at the angle of advance and produce it through the centre O to the opposite diameter. Call the two points where the circumference is cut E and E'. With OE and OE' as diameters, describe two circles. These circles are called the valve circles, and the circumference of these circles gives a line for locating the various valve positions.

As it is the outside lap that governs the steam admission and cut off, an arc



THE TWO UPPER DIAGRAMS SHOW POSITION OF CRANK WHEN PISTON IS AT HALF STROKE. THE LOWER DIAGRAM SHOWS POSITION OF PISTON AT CUT OFF WHEN LEAD IS EQUAL BOTH ENDS.



EXAMPLE OF ZEUNER DIAGRAM.

of a circle with radius equal to the outside lap is drawn with O as a centre, and by drawing lines through the points where this arc cuts the valve circle we obtain the crank position for admission and cut off, A and C. The length of the line from the centre to the valve circle gives the travel of the valve from its mid position at that point. A line drawn across the diameter of the eccentric circle, tangent to the two valve circles, gives the position of crank when valve is in midposition.

So far we have got the operations for the steam edge of the valve. We now require those for the exhaust. To obtain these positions we draw an arc equal in radius to the inside lap of the valve, and cutting the lower valve circle at the circumference. If we now draw lines from the centre of the eccentric circle through the points where the arc cuts the valve circle, the one to the right represents the crank position at release, and the one to the left the crank position at compression. The length of the lines from centre of eccentric circle to circumference of valve circle gives the displacement of valve from its midposition. Likewise the length of line between lap circle and valve circle represents the port opening. Thus it will be noticed that with crank at dead centre the port opening is represented by the length of line P P. At the cut off point, release and compression, the three lines coincide, and also at the admission point. The lines D E and E F represent the maximum port opening.

It will thus be seen that here is a quick and easy method of finding out all about the motion of a slide valve. By it valves can be designed, or the action of the present valves checked up. The effect of moving the eccentric either ahead or back can be plainly seen on the diagram. Increased inside or outside lap reflects its influence on the diagram in a way that is unmistakable.

We will deal with the diagram further in our next article.

TO MAKE FUEL CONTRACT

W. L. Chandler, of the Dodge Sales & Engineering Co., Mishawaka, Indiana, president of the National Association of Purchasing Agents, has called a meeting of the Fuel Committee of this organization to be held at the William Penn Hotel at Pittsburgh on February 18 and 19.

The purpose of this meeting is for the fuel committee to meet and discuss a fair, equitable, and inviolate form of contract governing the purchase and delivery of coal.

There will be about thirty-seven members of the fuel committee present, each representing a local association. Ernest H. Hawkins, E. I. duPont de Nemours Company, Wilmington, Delaware, will act as chairman of the committee and of an advisory council of five members of the fuel committee.

It is the purpose of the fuel committee to reach some form of contract which may be standardized and at a later meeting the advisory council will meet with representative coal operators, distributors and purchasers to secure their advice and co-operation relative to the provisions of the contract as worked out at this meeting.

The proposed contract form is attracting wide attention according to the New York headquarters of the National Association who report receipt of several hundred letters from some of the largest and most influential organizations in the United States, discussing the proposed contract from various angles.

C. A. S. E. TORONTO OPEN MEETING

On Wednesday, February 23, the Canadian Association of Stationary Engineers, Toronto Lodge, will hold an open meeting in the Temple Building, Bay Street, at 8 p.m.

This promises to be an interesting evening, the subject of the lecture to be given being "Diesel Engines." The Diesel will be described and illustrated by slides, and the lecturer will be Mr. Brown, who designed the first true Diesel to be built in Canada.

In view of the important place this type of engine will probably assume in the near future, all those who can do so should take advantage of this opportunity. They will be sure to enjoy it.

CHIMNEY TEMPERATURES

An instrument has been produced for ascertaining the temperature of a chimney at various depths. The apparatus consists of three tubes extending to various depths, and enclosed in a long, pointed steel case. These tubes end in bulbs, and are filled with alcohol. At the upper end of the instrument are three dial temperature indicators, each connected to a tube. The scales on the dials range from 32 deg. to about 200 deg. Fah., and are colored black up to 120 deg., but upwards from that temperature the color is red, indicating excessive heats. If several of these devices are forced into a coal pile at varying depths and in different localities, accurate information can be gathered for the whole of the pile. It is stated that instruments employed at intervals of 50 ft. have proved very effective.

Fatal Accident.—Lying on his stomach, looking down an elevator shaft in the Sunbeam Lamp Works, 221 Dufferin street, Toronto, George J. Pond, aged 45, of 15 St. Clarens avenue, was crushed to death by the elevator cage. Fred Read, 146 Booth Avenue, was searching at the foot of the shaft with a lantern for a gold locket which had been dropped. He was standing in the pit below the basement and the elevator does not descent below the level of the basement. This saved Read from meeting with the same fate as Pond. The machinery of the elevator was started through some unknown agency, and the cage slid down the shaft pinning Pond and crushing his skull. The body was removed to the Morgue, and an inquest will be held. Mr. Pond is survived by a widow and six children.

Some Points on Erecting and Lining Up

Erecting Shop Practice is Introduced, and the Complete Process Of Erecting Will be Explained. The Present Article Deals With the Main Frame Castings of a Horizontal Engine

By "Fitter"

THERE seems to be a considerable amount of difficulty on the part of some young engineers in mastering the art of lining up.

It is not a very difficult matter, but one that calls for care and accuracy in making a few simple adjustments. Lining up is usually called for in an engine that has been in service for some time, but it is also required when the engine is first erected in the erecting shop of the firm that makes it. The engine has again to be lined up when it is set up in the engine room of the purchaser. On neither of these occasions does the operating engineer have much to do with it. In the first case he has nothing, and sometimes in the second case the engine is erected and has had a trial run before he comes on the job. Thus it may happen that an operating engineer is a good many years at the trade without running into the problem. For the benefit of those who have had no shop training it might be of help to give a brief outline of the method pursued in erecting an engine in the shop.

Erecting Shop Practice

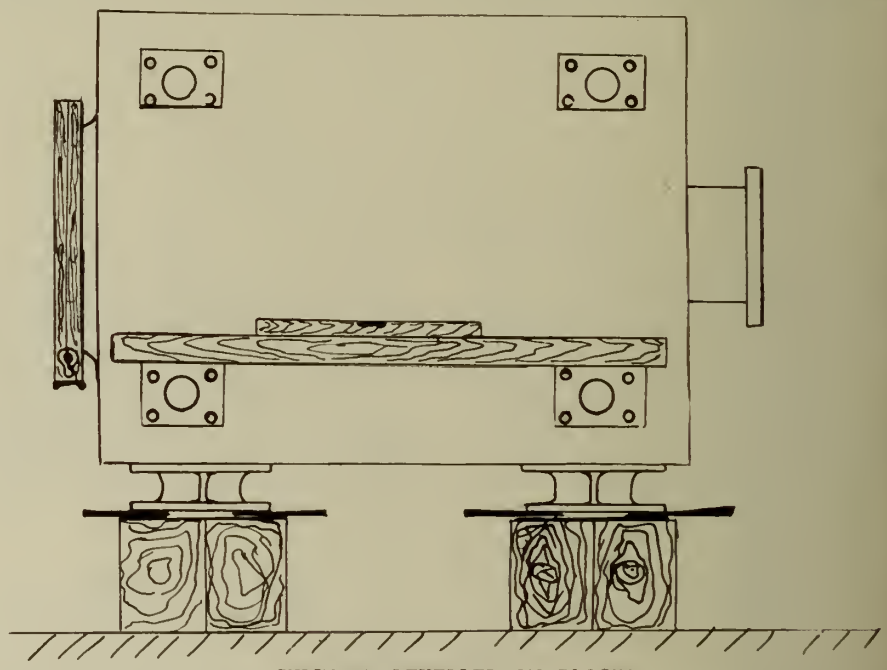
The first part to be erected in a horizontal engine is the cylinder. In a vertical engine, of course, the cylinders cannot be put on until the bed plate and columns are set up. We will consider the horizontal engine first, as this is by far the most common type. Let us take the example of a Corliss single cylinder engine, with overhung crank, fly wheel, and outboard bearing.

The cylinder comes to the erecting shop after being bored to the correct size, stuffing box bored out, and faced, cylinder faced for the cover, holes drilled, and tapped for the studs, valve chambers bored out, the ends of the valve chambers faced off to receive the covers, with holes drilled and tapped, and holes for indicator connections and drain cocks drilled and tapped. The studs may also be put in by the fitting shop gang or they may be put in by the same machine that does the drilling and tapping. Practice varies in this particular.

Square blocks of timber are laid on the floor at right angles to the line of the engine. These are for the cylinder feet to stand on, and it is good practice to lay a sheet of 18 to 20 gauge iron on the top of the timber. Iron wedges are kept in readiness, and as the cylinder is swung up by the shop crane, and brought over the timbers, the wedges are placed on the sheet iron, so as to support the cylinder when it is lowered. There are usually four feet or supports, one at each corner of the cylinder, and it is a good thing to put four wedges under each foot. This allows of easy adjustment. The placing of the sheet iron on top of the timbers allows easy movement of the wedges as they are tapped in or out. If placed directly on top of the timbers they would cut into the wood, and render readjustment difficult.

Having landed the cylinder, the next thing to do is to level it up. It must be levelled both in a longitudinal and transverse direction. Vertical and horizontal centre lines will probably have been marked on the cylinder end by the marker-off, when he laid out the stud holes, and also the mark for boring. If they are not available, they can be made from the drawing, which shows the position of the studs. It is usual for a stud to be placed on the vertical centre line top and bottom, and very often there are studs on the horizontal centre line. If this is the case, a steel straightedge can be laid across these studs, and a spirit level placed on the straightedge. This will give the horizontal setting. If this cannot be done, a plumb bob can be dropped down the centre line and the cylinder adjusted till the vertical centre line coincides with the string of the bob. If there are studs on the vertical centre line top and bottom the steel straightedge can be placed against these studs and a plumb rule or spirit level plumb rule placed against the straightedge. Either of these ways will give the desired result.

To get the cylinder level in the longitudinal direction, the spirit level can be placed in the cylinder bore, but this is not a very handy way to read it. In levelling, it is best to get the reading over as long a distance as possible. A short level laid on a true surface may show true, but if the same level is placed on a straightedge laid across two planed surfaces some distance apart, and moved along from one end to the other, a slight amount of out-of-lineness is plainly shown. Therefore it is better to lay the straightedge across the top of the valve chamber faces, which are usually machined. If this cannot be done, the cylinder can be levelled by the plumb rule placed across the end of the cylinder, which will give it in a satisfactory way. In any case, this can be used as a check, even if the spirit level can be used horizontally.



CYLINDER LEVELLED ON BLOCKS.

The cylinder is now level in every direction, and ready for the placing of the girder frame. This girder frame is in some cases cast integral with the main bearing casting and in others is a separate casting, bolted to the cylinder at one end and the main bearing casting at the other. In either case, it must be absolutely in line, as it carries the crosshead guide shoes and forms the guides for the piston rod. These girder frames are usually bored out to carry the circular guide shoes and the holes will have been drilled in the frame to receive the studs on cylinder and also on main bearing casting. The pitch circle of these studs will be concentric with the circle to

which the guides are bored, so that when the frame is bolted up, it will have its centre on the centre line of the engine. If the frame is cast together with the bearing casting, then this will have to be blocked up level at the same time. In this case the crane would pick up the whole frame and pillar block casting, and the blocking would be put in under it and the cylinder end eased on the studs at the same time. Care would have to be taken to see that the bearing was blocked up high enough to take any bending strain off the studs before the crane is slacked off. If the girder is separate from the main bearing casting it can be fastened on to the cylinder studs and the far end blocked up in readiness for the main bearing casting. The main bearing casting in this case would be landed on blocking with the studs just clear of the frame girder, and with the blocking so arranged that the casting could be pried over till the studs had entered the holes all fair. It would then be pushed to its place.

The main part of the engine is now in place, consisting of cylinder girder frame and main bearing. The next thing to do would be to go over the whole frame again with level and plumb to make sure that it is level from end to end and also sidewise. The top of the main bearing casting being planed makes a good surface to level off, and the circular guides on the girder frame make another levelling point. A long straightedge laid on the guides should be used, as otherwise the level may be thrown off by the radius of the guides. Straightedges that give a longer surface to run the level over than the surface being levelled should always be used.

Having ascertained that the frame is dead level all ways, the outboard bearing can be put down in a position approximating its final position. It will, of course, be laid on blocking in the same manner as the other parts, so that it can be easily adjusted.

The next job will be to line up the bearings at right angles to the cylinder centre, and check up the dimensions of journal boxes and bottom brasses to see that the centre line of crank shaft comes in line with centre line of engine.

(To be continued)

The Use of Chains and Other Lifting Gears

THE department of internal affairs in London, England, have issued a pamphlet dealing with the use of chains and other lifting gears. This subject is dealt with in considerable detail, but the data to follow form the portion that we believe will be of especial interest to our readers.

The safe working load for chains is given, in tons, as six times the square of its diameter. This differs from the American rule, which is $2.8d^2$—this giving a factor of safety of 4.5. Descriptions of the various types of chain and attachments are given, and the table, as shown in this article, is used to illustrate the safe loads that can be put upon two-legged slings, with the legs at various angles.

The pamphlet also includes some remarks on the testing, inspection and annealing of chains, and concludes with the following summary of precautions:—

(1) Chains and other appliances used for lifting purposes should be obtained from reliable manufacturers. The maximum working load and the purpose for which the chain or appliance is to be used should be clearly stated when ordering.

(2) No chain or other appliance should be used for lifting or similar purposes unless—(a) A test certificate has been obtained from the manufacturers showing the proof load to which it has been subjected and the name of the person responsible for the test; (b) a guarantee has been obtained from the manufacturer as to the quality of the material used, and that the chain or appliance has been thoroughly examined by a competent person after testing and found free from flaws, defects or deformation.

(3) The necessary information should always be available for any person using a chain or other appliance, to enable him to ascertain the safe working load for such chain or appliance.

(4) The maximum working load for any short or close-link chain should not exceed $6d^2$ tons, when used under normal conditions without shock; $5d^2$ tons, where there is any special danger to life or limb, or $3.5d^2$ tons where the chain is subjected to shock or heavy wear, or is used for lifts of molten metal or heated liquid; d being the diameter in inches of the iron of the chain. The maximum working load for a long-link chain should not exceed two-thirds of that for a short-link chain of the same diameter.

(5) When chain slings with two or more legs are used with the legs inclined, care should be taken to ensure that the maximum load in each leg does not exceed that given in recommendation 4 of the table shown.

(6) When the actual weight of an article to be lifted is not known, an approximate computation should be made, and lifting appliances should be used which allow an ample margin of safety.

(7) Load indicators and overload detectors should be used in connection with lifting appliances, especially jib or derrick cranes, whenever reasonably practicable.

(8) Slings or other chains should never be shortened by tying knots in them, and wood or other suitable packing should be provided to prevent the links coming in contact with corners of loads of hard material.

Safe Working Loads for Two-legged Slings.

Chain diameter inches	Safe working loads in tons and cwt. for given angles between legs. 0 deg.	30 deg.	60 deg.	90 deg.	120 deg.	150 deg.
3/16 ...	0-8	0-8	0-7	0-5	0-4	0-2
¼	0-15	0-14	0-13	0-10	0-7	0-3
5/16 ...	1-3	1-2	1-0	0-16	0-11	0-5
⅜	1-13	1-12	1-9	1-3	0-16	0-8
½	3-0	2-17	2-12	2-2	1-10	0-15
⅝	4-13	4-10	4-0	3-6	2-6	1-4
¾	6-15	6-10	5-17	4-15	3-7	1-14
⅞	9-3	8-17	7-18	6-9	4-11	2-7
1	12-0	11-11	10-7	8-9	6-0	3-1
1⅛	15-3	14-12	13-2	10-14	7-11	3-18
1¼	18-15	18-2	16-5	13-5	9-7	4-16
1⅜	22-13	21-17	19-12	16-0	11-7	5-17
1½	27-0	26-1	23-8	19-1	13-0	6-19
1⅝	31-12	30-1	27-8	22-8	15-16	8-3
1¾	36-15	35-9	31-16	25-19	18-7	9-9
1⅞	42-3	40-14	36-10	29-16	21-1	10-17
2	48-0	46-8	41-11	33-18	24-0	12-7
2⅛	54-2	52-6	46-18	38-5	27-1	13-19
2¼	60-15	58-12	52-12	42-19	30-7	15-13
2⅜	67-12	65-6	58-12	47-16	33-16	17-8
2½	75-0	72-9	65-0	53-0	37-10	19-7

(9) Sling chains and other lifting appliances, when not in use, should be stored under cover and kept on suitable racks or pegs.

(10) Every chain or appliance used for lifting purposes should be marked with an identifying letter or number, either on the chain or appliance or on a tablet attached thereto.

(11) All chains and other lifting appliances should—(a) If used for lifting in connection with molten metal or molten slag, be examined at least once in every month and be annealed at least once in every six months; or (b) if used in connection with lifting machinery or plant operated mechanically or electrically, or used for lifting in metal foundries other than that mentioned in paragraph (a) above, be examined at least once in every three months and be annealed at least once in every twelve months; or (c) if used for classes of lifts other than those mentioned in (a) and (b) above, e.g., in connection with hand cranes, be examined at least once in every six months and be annealed at least once in every two years; or (d) if used for holding down any crane or other lifting machinery upon a stage or platform should be examined as far as reasonably practicable, in situ, at least once in every three months, and be fully examined and annealed at least once in every twelve months, unless the nature of the operations preclude such examinations and annealing.

(12) A chain or other appliance should not be used for lifting its maximum working load if the wear at any part exceeds 10 per cent. of the nominal dimension of that part, or for lifting any load if it has been subjected to a severe shock or is deformed or otherwise injured.

(13) A chain or other appliance which has been altered or repaired should be re-tested before use.

(14) A record with full particulars should be kept of every chain or other lifting appliance.

POWER HOUSE

Member of the Audit Bureau of Circulation

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Don't Lose Your Interest

TWO recent letters in the daily press, both apparently written by members of the stationary engineering fraternity, are worthy of notice. The first of these letters called attention to the waste of fuel that goes on day by day in industrial and domestic furnaces. The second one fully endorsed all that the writer of the first had to say about waste and the remedies for the same, but claimed to be in a place where it was impossible to interest the boss in such a matter as fuel conservation.

The writer of this letter claimed that the plant he was in was run in a wasteful manner as far as fuel was concerned and no amount of representation on his part could remedy matters. The result was that he was about to give up in disgust. Though it seems hard to believe that in these days there can be factory owners so blind to their own interest still we must believe that the writer of the letter was sincere in his statements. The thing is, should any man, while still remaining in charge of a plant, relinquish his efforts and let things slide? It may be perfectly true that he can go on drawing his wages just the same and with far less worry to himself if he does this and probably feel also that he is being just as much appreciated. There is one man, however, who knows he is not doing his best, and that is himself. No man who has his heart in his business and is honest to himself will go on drawing money when he is not doing the work to earn that money. He may try to comfort himself by saying that he is doing all that he gets paid for. That is a wrong idea. When a man sells his labor he should get the full market value for it, but he should on his part give the full value of what is in him in return.

There is no doubt that a large percentage of employers do their best, whether intentionally or not, to discourage the man in charge of their plant. They look on the power plant as a source of expense and not a producing part of the establishment. Every cent spent there is spent grudgingly and they rarely, if ever, give themselves the chance to learn a little about how things are run or what the engineer has to contend with. This type of employer is fortunately decreasing and we believe it rests with the engineers themselves to educate those that remain out of their wrong point of view.

The engineer who is sure of his facts and can sit down and give them in cold figures, can approach an owner or manager knowing that he can get a hearing. If you can't leave the engine room long enough to have a good talk in the manager's office, ask him to come down to the engine room and spend a little time with you. You will probably be able to set him thinking even if he doesn't respond too well the first time. Try to have a general knowledge of the requirements of the different parts of the factory from a power and heat requirement angle. Have at least an approximate idea of what your power costs are and where you can bring them down by the particular piece of apparatus you want. Know your ground and then tackle the powers that be like a man. If you can't get what you want, then do the best you can with what you have until you can find something more congenial. While you are on the job, give it your best, for your own satisfaction, the respect of your fellow engineers and the credit of the stationary engineer in general.

Central Heating Plants

THERE has been recently some renewed agitation for the central heating plant in the interests of fuel conservation. We have no doubt that the establishment of these plants where the conditions are favorable would save an enormous amount of waste. There are quite a few plants of this nature already in operation and achieving good results, but in order to do so they must be properly laid out and provision made for returning the condensed steam to the boiler. In towns of medium size where there is an electric light plant or street railway plant which operates at very low load factors for part of the time, or as in many cases, has long spells under banked fires and standby conditions, there is a very good chance of making a profitable investment of a central heating system.

In a plant of the latter class, which may be called upon to supply power at any moment, the labor costs and overhead are going on all the time, whether the plant is supplying power or not. The boilers are under steam and the standby losses which are so important a part of the costs of central stations are present for a goodly portion of the day with nothing to cover them in the way of revenue. The amount of fuel necessary beyond that used for keeping steam handy that would be necessary to supply a well-designed heating system would not be very great and would enable householders and office buildings to obtain their heating at a much smaller cost than that of running their own furnace. There would also be a considerable saving to the ratepayers in that the cost of collecting ashes by cart from each house or office building would be eliminated. Instead of unconsumed gases leaving a thousand different chimneys there would be but one chimney and that, due to efficient operation, would deliver but little smoke.

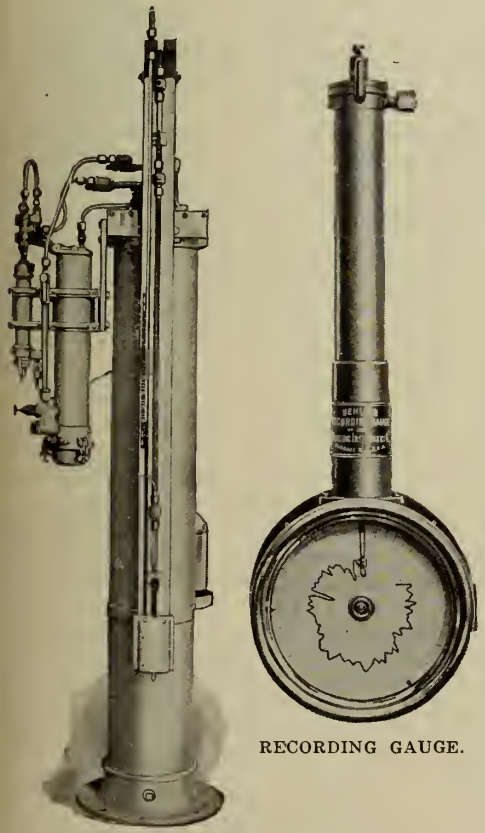
The central heating plant would be more economical, cleaner and a great deal more satisfactory to all concerned than the present method of individual heating and in a country like this it should have a very wide field.

Progress in New Equipment

NEW CARBON DIOXIDE RECORDING EQUIPMENT

Coincident with the present acute interest in better boiler economy, the Uehling Instrument Co., 71 Broadway, New York, has introduced a new model CO_2 recording equipment, known as style U, which embodies important improvements over the superseded model. Chief among its advantages are remarkably quick action, greater accessibility and simplicity of parts, and the economy of combining in one machine means for determining CO_2 simultaneously from any number of boilers, up to a total of six.

A single unit Uehling CO_2 equipment for one boiler consists of three principal parts, namely, the CO_2 meter proper, Fig. 1, recorder, Fig. 2, and auxiliary boiler front indicator, Fig. 3. The meter is placed wherever most convenient. Its function is to actuate the boiler front indicator and recorder in the engineer's office.



SINGLE UNIT METER.

RECORDING GAUGE.

The flue gas is analyzed, that is the CO_2 is extracted, in the meter. The principle involved in the operation of this machine depends upon the change in pressure caused by a change in volume in a stream of gas flowing through two apertures. Referring to Fig. 4, gas is caused to flow continuously through first aperture (A) and then (B) by means of

DRY ABSORBENT CARTONS.

an aspirator or syphon. A reduction of the gas volume between the two apertures, by absorption of the CO_2 content, causes a change of pressure or tension in chamber C which is transmitted to recorder and indicator, calibrated in per cent. CO_2.

The CO_2 meter consists essentially of a cylindrical regulator on which is mounted the analyzing mechanism. This regulator maintains constant the suction created by the aspirator, thereby eliminating all changes in tension between apertures (A) and (B) except those caused by absorption within chamber C. It is the latter changes in tension which the indicator and recorder register.

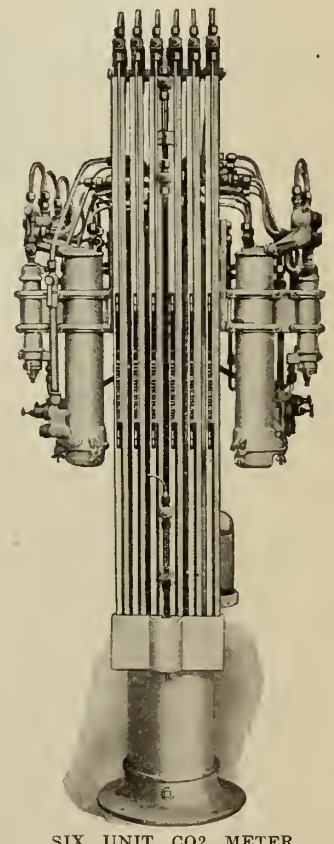
Suction in chamber C actuates the recorder and indicator instantaneously and continuously. The only appreciable lag was formerly in the travel of the gas from boiler to chamber C. In the new model the gas travel is hastened by utilizing the main aspirators exhaust in an auxiliary aspirator for the purpose of drawing the gas from the boiler up to the absorption chamber while the main aspirator draws the gas sample through the absorption chamber.

With each unit is included a preliminary filter which removes soot and dirt from the sample before it reaches the intermediate and final filters on the machine. This has been redesigned so that the filter chamber can be conveniently cleaned in a few seconds without interrupting operation of the machine.

Multiple equipments combine in a single outfit means for measuring CO_2 from 2, 3, 4, 5 or 6 boilers independently and simultaneously. It is most economical to equip the boilers in batteries of six each, but this is not absolutely necessary, inasmuch as the CO_2 meters are now built on the "unit" or "sectional" plan and may be added to from time to time. For example, a plant can purchase a single-unit, two, three, four, or five-unit equipment initially and easily attach additional units, up to a total of six, as new boilers are installed.

With multiple unit machines each boiler is equipped, as previously mentioned, with its own recorder, auxiliary boiler front indicator, preliminary filter, and absorbent chamber with necessary appurtenances, but the aspirator and other parts of the master unit serve all units in common. A six-unit meter is illustrated in Fig. 5.

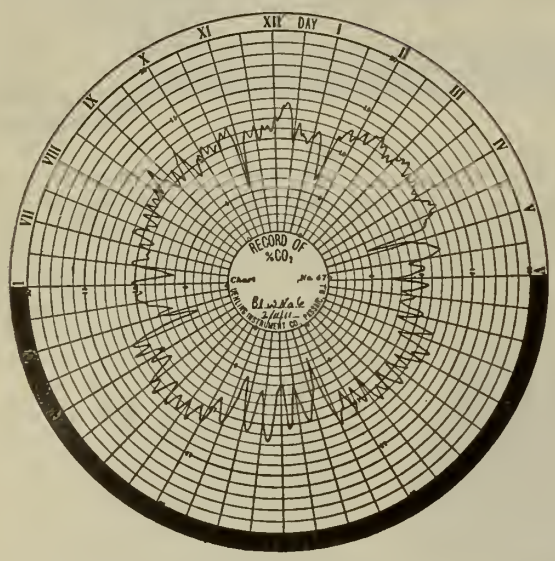
The recorder, Fig. 2, operates on the hydrostatic principle, by which all springs, levers and joint movements are avoided. It makes a continuous (not intermittent) record of the per cent. CO_2 furnishing an autographic history of the operation of each boiler for every second of the day, showing when fires receive attention; when and how often furnace doors are opened, or how often stoker



SIX UNIT CO2 METER.

speed and fuel bed thickness are changed; fires broken and cleaned; effects of changes in damper regulation and methods of firing. Thus the real facts are recorded and the fireman gets a square deal.

The boiler front indicator guides the fireman in supplying just the right amount of air to burn the fuel with the least loss of heat up the chimney.



CONTINUOUS RECORD CHART.

CO2 INDICATOR.

CATALOGUES

The Gardner Governor Co., Quincy, Ill., have forwarded bulletins describing their steam engine governors, duplex steam pumps, and duplex power pumps. The bulletins are well illustrated and give full particulars of the subjects dealt with. The pumps are designed for all purposes, and the power pumps arranged for direct motor or belt drive. The governors are of the fly ball type, with emergency safety attachments.

Escher Wyss & Co., the well-known Swiss engineering firm, announce that Mr. Th. Seidl has returned to take charge of their Montreal agency. Mr. Seidl will combine the duties of chief engineer and manager, while Mr. C. H. Withers, who has been in charge during Mr. Seidl's absence, will remain as assistant manager. The company have added to their general engineering lines some special apparatus for use in chemical works and sulphite mills.

Bulletins No. 240 and 241 of the Dayton Dowd, Quincy, Ill., describe their single and multiple stage centrifugal pumps. The multiple stage pumps are made up to four stages, but where there is necessity for more stages than this the makers advise the installation of two units. They explain that there is no limit to the number of stages that can be used in a pump, but owing to mechanical features such as distance between bearings the two unit system is recommended for all stages above four.

The Griscom-Russell Company, 90 West street, New York City, manufacture a device for the cooling of oil used in the lubrication of turbine bearings, reduction gears or quenching oil in the heat treating of steel. In either case the oil is constantly circulated through the cooler, thus maintaining the oil at a constant temperature and permitting the continued use of the original quantity of oil and its maintenance at the proper viscosity for efficient results.

The apparatus takes its name from the whirling path of the oil, which path is accomplished by the use of the helical baffle which directs the oil in its flow without appreciably retarding its progress. This baffle also serves to bring the oil into intimate contact with the cooling surface and it insures a high rate of heat transfer.

We have received bulletins from the American District Steam Co., North Tonawanda, N.Y., describing several of their products for steam plant use. These include Adsco Angle fittings, which are special flanges with slotted holes for giving an offset to pipes without the interposition of special ells. The pipe can be offset to any required degree by these fittings. The Adsco adjustable wedge is for making up two pipes which do not fall into line, and can be used for any offset up to 10 degrees. A second bulletin No. 151 describes the rotometer, a rotary condensation meter, of convenient design and size. Bulletin No. 152 describes the Adsco water heaters for domestic hot water purposes, also for institutions, etc.

The shell is of cast iron and the tubes of seamless drawn brass or copper, expanded into a fixed tube plate at one end and into a floating head at the other, which latter permits expansion and contraction without strain on the tube joints.

TRADE GOSSIP

Must Quit Union.—Twenty-two electricians, mostly outside linemen, employed by the Winnipeg City Light and Power Department, were suspended and paid off for failure to comply with the order of J. G. Glassco, manager, that they sever their connection with the Electricians' union. The men, it is understood, will be given a day or so to comply with this order, failing which they will be permanently dismissed.

The Dominion Engineering and Construction Company has been organized for the manufacture of "Delco" machinery and "Viking" pumps. A plant has been established in Longueuil across the river from Montreal, and machinery is now being installed. It is expected that the factory will be in operation within a short time. A. G. Kidston & Co., 17 St. John St., have been appointed the Canadian selling agents.

The Grand Trunk Point St. Charles shops in Montreal will be closed during the present week, for the purpose of overhauling the power equipment, general transmission and air compressors. A complete inventory has been taken recently of every machine and piece of equipment, and also the buildings, for the information of the arbitration board now sitting in Montreal, in connection with the handing over of the road to the Dominion Government.

The Engineering & Sales Service Co. of Montreal are now well established in their new premises at 179 Duke St. In addition to their sales service the company are acquiring machinery and equipment for the carrying on of a general jobbing and repairing business. It is expected that the company will be manufacturing Promet here in Montreal in the course of a few weeks. For the past couple of years the Engineering Sales & Service Co. have been the sole Canadian distributers for this metal.

Roy M. Wolvin, president of the Dominion Steel Corporation, has returned from England, where he has been in conference with officials and others interested in the steel merger, but no immediate announcement will be made as to what has been decided regarding the early developments of the British Steel Corporation. Regarding the Dominion Steel Corporation's connection with the proposed merger the president remarked: "Matters have not yet reached a point where any definite statement affecting the affairs of the company can be made."

INTERESTING BOOK

The Taylor Instrument Co., Rochester, N.Y., have issued a very attractive January issue of The Tycos-Rochester. This is a little book devoted to things scientific, and, of course, deals more or less with Tyco equipment. It proves interesting reading, however, apart from its trade flavor.

A Description of a New Reversing Turbine

An 8-inch Model of This Turbine Has Been Tested Out by Prony Brake and Also in Driving a Forced Draught Fan, and Gave Good Results

THE present invention relates to improvements in a steam turbine and the main object is to provide a device of this character whereby a steam supply will be automatically regulated or cut off. A further object is to provide a turbine of simple design and particularly cheap of construction. Another object of the invention is to provide means whereby a steam chamber is provided with an eccentrically disposed drum thereby allowing for steam expansion, said drum being provided with a central rotating paddle which is slidably mounted in said drum.

The invention will be better understood with the following accompanying drawings, in which:

Fig. 1 is a side elevation of the turbine, the upper half portion being shown in a longitudinal section. Fig. 2 is a cross section view on line A-A of Fig. 1. Fig. 3 is a front elevation of the steam supply controlling device. Fig. 4 is a longitudinal section view on line B-B of figure three (3). Fig. 5 is a cross section view through the eccentrically mounted drum.

Like numerals of reference indicate corresponding parts.

In the drawing, Part 1 indicates the base and Part 2 is a circular casing having at one side thereof an opening (Part 3) closed by a plug. Parts 4, 5 and 6 are outlet and inlet steam passages provided in the sides of said casing, said passages communicating at one end with the interior of said casing and Part 2 at their other end with a circular valve casing, Part 7 which is preferably integral with said casing (Part 2) at each open end of said casing (2) are cover plates. Parts No. 8 and 9 which are suitably secured thereto by means of the bolt (Part 10). Each of the said cover plates No. 8 and 9 are provided with corresponding eccentrically disposed openings (Parts 11 and general bearing No. 12) in which is rotatably mounted the cross shaft Part 13. Rigidly secured on said cross shaft, Part 13, is a drum (Part 14) which is preferably of same width of said casting (Part 2) and is provided with a central slot (Part 15) which projects therethrough and is adapted to register with the slot (Part 16) in the shaft (Part 13). The said drum (Part 14) may be provided with a plurality of longitudinal packing strips (Part 17) which are provided to form a staunch friction joint between said drum and portion of said casing 2.

The drum (14) being eccentrically mounted in relation to the casing Fig. 2. forms a steam expanding chamber (18) which is adapted to communicate on each side of said drum with the outlet and inlet passages (5 and 6).

Movably mounted within said slots 15 and 16, in the drum and cross shafts is a rectangular blade (19) which is provided with curved ends adapted to be in continuous contact with the inner circumference of said casing (2), said blade being provided with a plurality of friction members (20) mounted in suitable recesses and so arranged as to contact with the side of the casing or the inner sides of the slots (15 and 16) by means of the spiral springs (21) which are enclosed in suitable recesses.

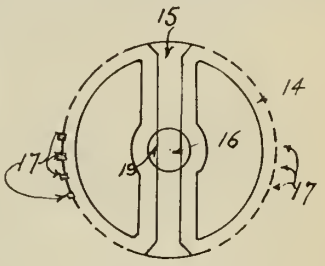


Fig. 5.

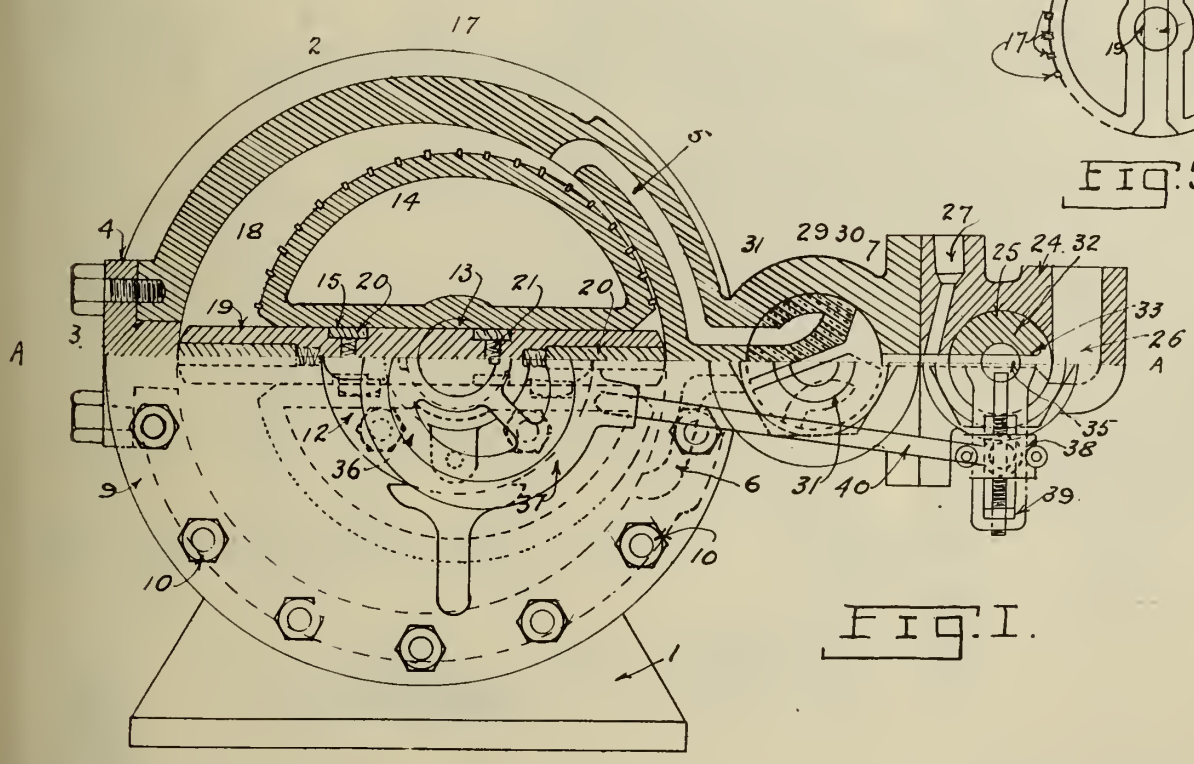


Fig. 1.

The valve recess (7) is provided with a passage (22) adapted to register with the passage (23) provided in the valve casing (24) which is suitably secured to the casing (Fig. 2) and 25 is a circular valve casing provided with the steam inlet (26) to which is preferably connected the steam supply pipe.

Intermediate of said valve casings 7 and 25, is a hole 27, adapted to communicate with the passage 22 and which may be used as an independent steam inlet when suitably connected to the steam supply pipe. The valve casing (7) is also provided with an exhaust opening

28 and 29 is a circular valve member rotatably mounted in said casing (7) and provided with a central passage (30) of a funnel shape at one end thereof which is adapted to register with the passage 22 and one of the passages 5 or 6 at the other end and 31 are exhaust passages provided on each side of said central passages and which are adapted to communicate with one of the passages 5 or 6 and the exhaust port or opening 28.

In the valve casing 25 is rotatably mounted a valve member 32 having a central passage (33) which is adapted to register with the passage 22 and steam inlet 26. The valve members 29 and 32 are preferably provided with outwardly projecting stems 34 and 35, the stem 34 is preferably manually operated by any suitable means, while the stem 35 is automatically operated by a cam (36) which is rigidly secured on one end of the shaft (13) and on which cam is slidably mounted a sleeve (37) which is operatively connected to the adjustable member 38 slidably mounted on the frame 39 by the connecting arm 40. The frame 39 is rigidly mounted on the stem 35 and 41 is a threaded pin having a cross head or handle 42 adapted to adjust the slidable member 38.

In the operation of the invention, the steam enters through the inlet 26, passes through the passage 33 in the valve 32, the passage 23 which communicates with the funnel shaped passage 30 and one of the passages 5 or 6.

Steam enters the chamber 18 in the chamber 2 which is so divided as to provide for the proper expansion of the steam at the same time causing the rectangular blade 19 slidably mounted in the drum 14 to revolve, until it passes the exhaust passage provided in said chamber (2).

In the drawings, the exhaust passage 5 registers with the exhaust port 31 provided in the valve 29 and the exhaust steam passes through the said 31 and enters the steam outlet 28 provided at the end of said valve casing (7). To reverse the turbine the stem 34 may be operated.

When the rectangular blade 19 has reached a predetermined point the steam supply through the inlet (26) is automatically cut off by the valve (32), which is operated by the cam (36), provided on the shaft 13.

It will readily be understood that the intermittent cutting off of the steam is regulated by screwing or unscrewing the threaded pin (41), which distances or approaches the slidable member 38, on which is pivotably secured the connecting rod (40), secured on a cam sleeve (37).

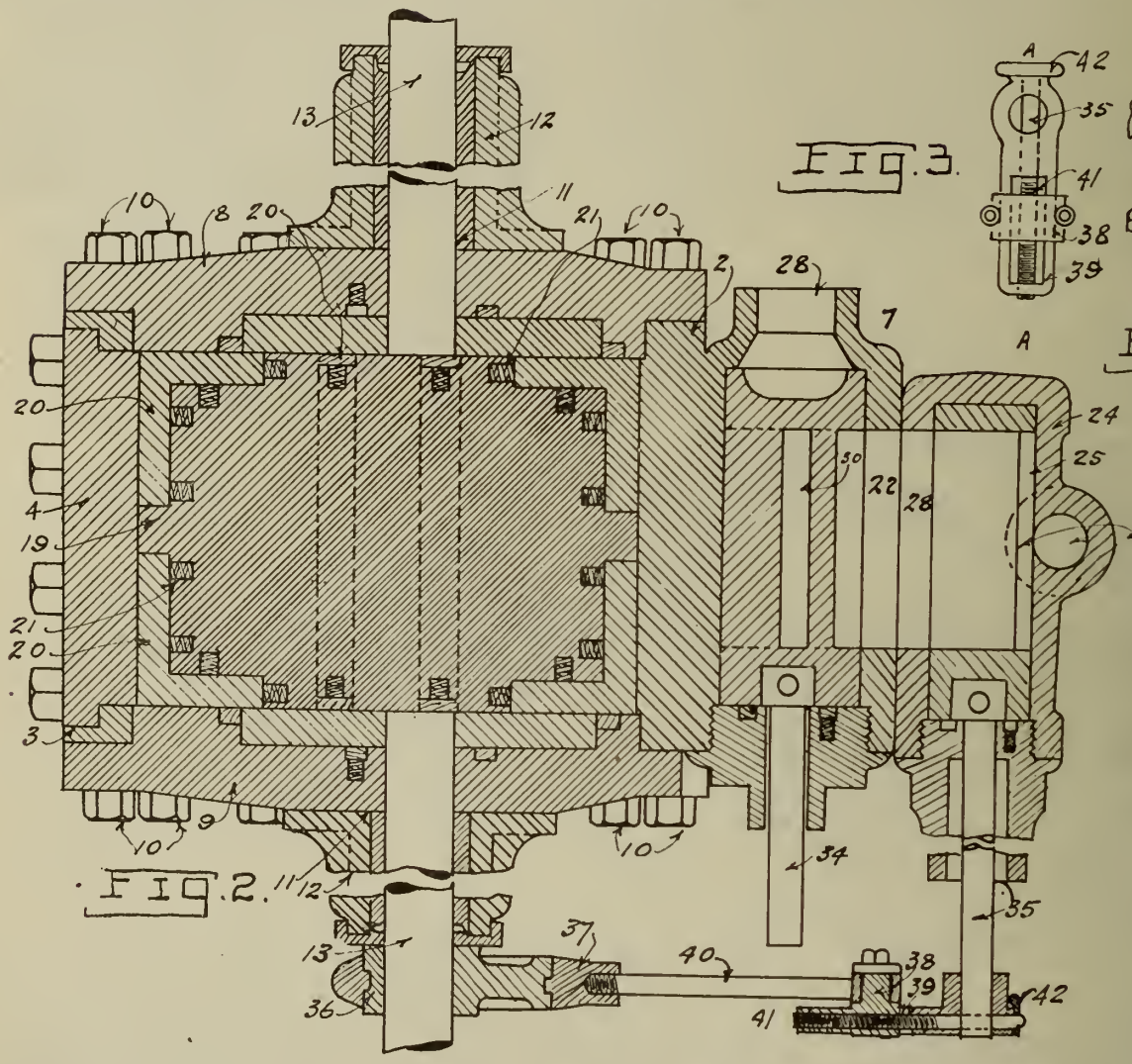


Fig. 2.

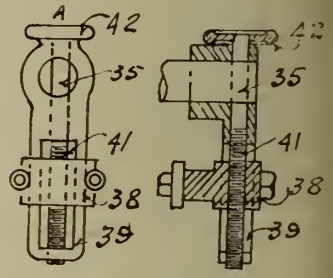


Fig. 3.

Fig. 4.

What I Claim As My Invention Is:

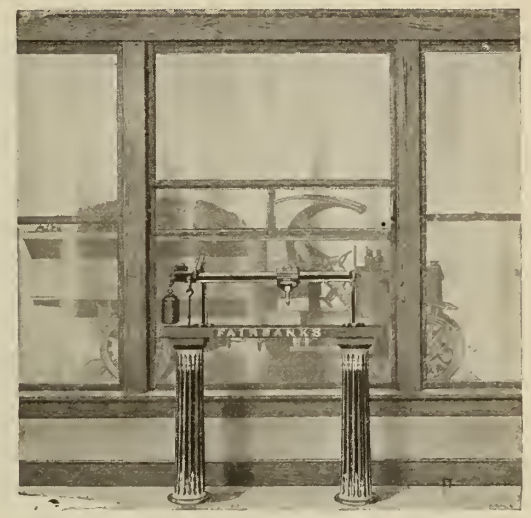
1. A turbine comprising a main ca ing, having an inlet and outlet port, rotary drum eccentrically disposed wit in said casing, rotating blade adapted contact at each end with inner circu ference of said casing and adapted to r tate said drum substantially as describ

2. A turbine comprising a main ca ing having inlet and outlet ports, a sha eccentrically journalled in the side said casing, a drum centrally mount on said shaft and adapted to provide friction contact with one side of sai casing, a slot provided centrally throug said drum and shaft and an operatin blade mounted on said slot and adapte to contact at each end with the inn circumference of said casing substan tially as described.

3. A turbine comprising a main cas ing having an inlet and outlet port, valve adapted to contact said ports, rotating drum eccentrically mounte within said casing operating blade con tacting at each end with the inner ci cumference of said casing and adapte to rotate said drum and means whereb said valve may be opened or closed auto matically at a predetermined time, thu

(Continued on page 40)

Fuel Consumption Statistics Depend On Accurate Weighing



Consistent accuracy in the weighing of coal is a necessity to the modern power house since it is the basis of all fuel consumption records.

Fairbanks Scales

are sturdily built to give unfailing, reliable service under the most severe power house conditions. The illustration below shows the strength and simplicity of the wagon scale parts.

Special Fairbanks Scales can be adapted to special situations and extension levers can be provided to carry beam up to 20 feet from platform of scale, placing it in an office or elsewhere at a price proportionate to the distance.

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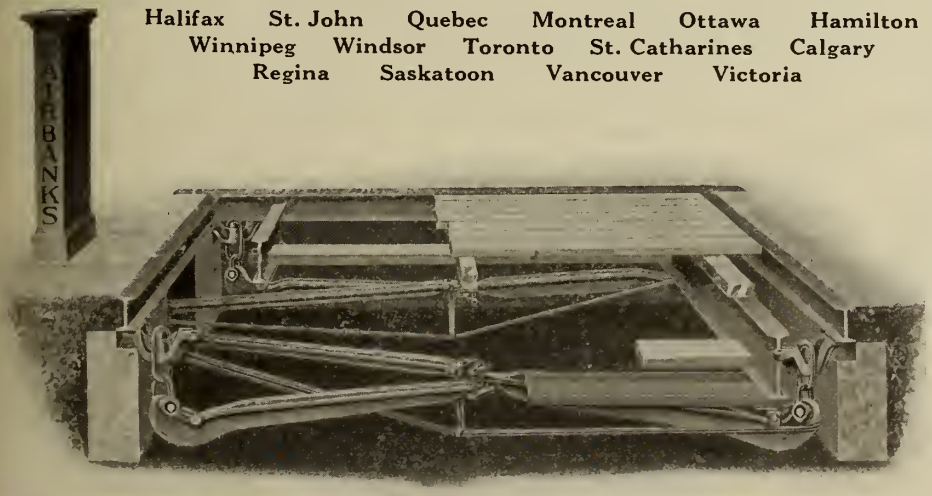

A NEW TURBINE

(Continued from page 38)

limiting the steam supply to said casing substantially as described.

4. A turbine comprising a main casing having an inlet and outlet ports, a valve adapted to control said ports, a rotating drum eccentrically mounted within said casing, a blade contacting at each end with the inner circumference of said casing and adapted to rotate in conjunction with said drum, means whereby said valve may be automatically opened or closed at the predetermined time to limit the steam supply to said casing and means to adjust said valve substantially as described.

5. A turbine comprising a main casing having an inlet and outlet ports, a valve casing adjacent said main casing, a passage communicating at one end with each of said ports and at the other end with the said valve casing, and said valve casing having an exhaust port and an inlet port, a rotary valve mounted in said valve casing provided with a steam inlet and steam outlet adapted to register with the passage communicating with said valve casing, a steam supply valve casing, a passage adapted to connect the steam inlet in the aforesaid valve casing to said steam supply valve casing, means to supply steam to said valve casing, a rotary valve member mounted in said casing, a rotating drum eccentrically mounted in said casing, a movable operating blade contacting at each end with the inner circumference of said casing and adapted to rotate said drum, and means whereby said steam supply valve may be opened or closed automatically at predetermined intervals to limit a steam supply to said casing substantially as described.

6. A turbine comprising a main casing having an inlet and outlet ports, a valve adapted to contact said ports, a shaft eccentrically journalled in the sides of said casing, a rotating drum mounted on said shaft, an operating blade adapted to project through said drum and contacting at each end with the inner circumference of said casing, a cam mounted at one end of said shaft adapted to revolve said valve and means to adjust the time intervals between the opening and closing of said valve substantially as described.

This model of steam reversing turbine was in operation in a small way, an 8 in. model, and was tried last fall, on November 24, at Levis, Quebec, at which time it developed 11.7 B.h.p., but this turbine shows to a better advantage when worked with vacuum and will develop more power. As I said before, it was tried with only 90 pounds pressure and gave the above result. It turned 600 r.p.m. with a load of 27½ pounds at the end of a 28 inch lever. It was also tried in another place to run a fan on board a vessel (Howden System Draft), to take the place of an engine 4½ inches by 7 inches. At another place it was installed to run a dynamo for 64 lamps and in all of the cases it gave better satisfaction than the engines did before, and besides was run at a great economy over the cost of running the engines.

MADE ADVANCES AFTER CLOSE STUDY

John J. Main Was Inventor of Note—Passed Away in Toronto Recently

John J. Main, inventor of the Heine boiler, and one of the outstanding figures in Canadian foundry circles, died at his home, 40 Prince Arthur Avenue. He had been ill a long time, and death folloewd a stroke, the fifth of its kind.

Mr. Main was born on the island of Jersey 70 years ago. He came to Canada as a young man, and for years worked at his trade as a boilermaker. It was the invention of the Heine boiler which gave him his real start in life. He became connected with the Polson Iron Works, rose rapidly, and when he retired three or four years ago was vice-president and general manager.

During the war Mr. Main served on the Imperial Munitions Board. Free of charge, he turned over to the military authorities his patents on boilers fed with crude oil, which were used extensively in many branches of the service.

Mr. Main was president of the Canadian Incinerator Company, president of the Policy Holders' Mutual Life Insurance Company, and a director of the Dominion Radiator Company. He was superintendent of the Doty Engine Company, John Inglis & Sons and the Bertram Engine Works at various times during his career.

OVERHEATING ALUMINIUM

While it is important to maintain a low-pouring temperature for casting aluminium alloys, it is equally important to avoid overheating the metal in the furnace charges. Doubtless some advantage is gained when overheated melts are allowed to cool to the correct pouring temperature, and part of the danger of overheating is minimized by so doing. Nevertheless, continues the Engineer, for aluminium, overheating is very objectionable because of the rate of dissolution of iron from cast iron melting pots and of the reduction of silica from clay crucibles, as well as absorption of gases from the local atmosphere. For molten metals, the absorption of gases increases with rising temperature, this being possibly due to the fact that metals form loose compounds with hydrogen and nitrogen. The absorbed gases are often held by the metal until solidification starts, when they are liberated and cause unsoundness. Hence an overheated melt would contain more absorbed gases than one not overheated, and it would be expected that castings poured from the former would be more unsound than those poured from the latter.

Switzerland is one of the principal producers of aluminium. In 1918 this country exported 10,500 tons of raw aluminum, to a value of 51,000,000f. To the figures stated must be added 2,000,000f. of bar and sheet aluminium, 6,500,000f. of technical appliances, and 3,200,000f. of other articles in aluminium. With the end of the war in 1919 the export of aluminium technical articles fell off, while that of household items was doubled. The latter exports rose to a value of 6,200,000f., of which one-fourth went to Italy and one-fifth to France.

GIANT ELECTRIC POWER STATION

The new electric power station at Glasgow, Scotland, takes rank as one of the largest in the country. It is designed for an ultimate capacity of over a quarter of a million horse power, and each generating unit—of which there are five in the first half of the station recently completed—will be of 24,000 horsepower. Each boiler is capable of producing 62,000 pounds of steam in an hour. All the latest labor-saving devices for loading coal into the bunkers, stoking the furnaces, and removing the ashes are installed, and a very high degree of economy in the production of electricity on a large scale is assured.

CATALOGUE ON CRANES

The Milwaukee Electric Crane and Manufacturing Company of Milwaukee, Wisconsin, has just issued a new 48-page catalogue illustrative and descriptive of their complete line of cranes. Much valuable information, the result of twenty-five years of active experience in the designing and building of hoisting machinery for shops, foundries, steel plants, and other establishments, is incorporated in this book.

Those interested in electric cranes or hoists, and especially in the prevention of accidents, will find this book chuck full of interesting data. A section of the catalogue is devoted to the horizontal drilling and boring machine made by this company and which is especially suited for operating, at one setting, on pieces too long or bulky for the usual type of machine.

Leaflet 1160-A has just been issued by the Westinghouse Electric & Manufacturing Co., which illustrates and describes the features of the Type CS Squirrel-Cage Induction Motors of this company. These motors are constant speed, continuous rated from 2 horsepower to 200 horsepower, 2 and 3 phase with 25, 40, 50 and 60 cycle, and 110, 220, 440, 550 and 2,200 volts. In addition to the discussion on the motor and its parts, the Type A auto starter and the Type 815 motor starting switch for 10 horsepower motors and below are illustrated.

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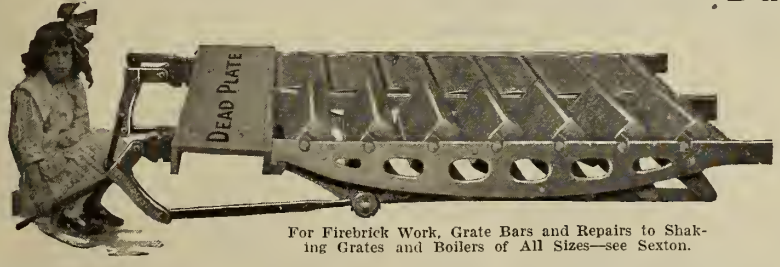

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Why don't you save at least 10 per cent. of your coal bill? We guarantee that Nonpareil Shaking and Dumping Grates will save you at least 10 per cent. Wouldn't it be to your advantage to investigate this? Communicate with us to-day!

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OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

TURNING MOMENT ON SHAFT

Question.—If an engine runs over and the crank is at 90 degrees from the head centre on the out stroke, what is the downward pressure on the guide? (2) What is the tangential pressure on the crank pin? (3) What is the thrust on the connecting rod? (4) What is the twisting effort on the crank shaft? The crank is 15 inches from centre of shaft to centre of pin. Connecting rod is 60 inches long. Diameter of piston 20 inches and pressure on piston 100 pounds. Friction and weight of parts to be neglected. Also please explain how blowing down a boiler will remove sediment that has collected on bottom of boiler.

Answer.—When the crank is at 90 degrees to the centre line the twisting effort on the shaft is at a maximum. The thrust on the connecting rod will be according to the angle it makes with centre line of engine, and the pressure on the guide will also be a maximum.

We have a piston area of $20\times20\times.7854$ and a pressure of 100 pounds per square inch, which gives a piston rod thrust of 31,416 pounds. The connecting rod is 60 inches and the crank 15 inches. Then the base of the triangle formed by crank rod and engine centre line will be $\sqrt{(60^2-15^2)} = 58.09$ inches and the thrust in the connecting rod will be $31,416 \times 58.09 \div 60 = 30,473.52$ pounds The pressure on the guide is the component of the load on the connecting rod perpendicular to the guide. That is, it is equal to the load on the crosshead rod multiplied by the height of the crank divided by length of rod, or $15\div60\times30,473=7,618.375$.

The tangential force is equal to the thrust in the rod when the crank is at 90 degrees. The twisting moment on the shaft is equal to thrust in the rod multiplied by length of crank. This question was dealt with in the issue of January 20 and a diagram illustrating the subject was given.

With regard to the sediment in the boiler, if this is hard and firmly attached to the shell, blowing down will not move it. When the scale or sediment is still soft or in solution the action of blowing down removes it by the scouring action taking place as the water rushes to the pipe. The same action can be observed in a bath tub when the plug is removed and the water only leaves by gravity.

A BOILER PROBLEM

Question.—I am firing a H. R. T. boiler and am burning "Mountain Park" (a slack soft coal) under it at the rate of 15 to 18 pounds per square foot of grate surface. I get good combustion and little smoke. I have a splendid draft and clean water in the boiler and when working hard the water in the glass raises and falls three inches within a few seconds. The boiler is used for heating a building and at low pressure five pounds is as high as needed. Is this boiler working beyond its economical capacity? Will you explain why if it is? Would I do better by using another boiler which is now lying idle and have slower combustion? If so can you tell me why, when I get good combustion with one? I have been told I am using more coal with one. Can you show me.

Yours truly,

K. P.

Answer.—With good draft and ordinary run of mine coal, the burning of 15 pounds of coal per square foot grate per hour is quite normal. Whether your boiler is being operated over its normal rating or not cannot be determined without knowing the size of the boiler, but generally speaking it is more economical to run one boiler at capacity or over than to run two boilers at considerably under capacity. You have in the latter case the loss due to infiltration of air, radiation loses and ashpit losses practically multiplied by two, besides having two fires to clean, with the loss attendant, which is naturally higher than with one. You should be able to judge by the quantity of water evaporated what results you are getting.

As to the fluctuation in water level, sudden demands for steam would cause that, though hardly to the extent you mention. If you have a very small steam space, sudden demands on the steam supply would cause a reduction of pressure, with a more violent ebullition of the water. This would cause severe fluctuations of water level. The kind of return system you have may have some effect on this.

SAFETY VALVE REPAIRS

Question.—I am operating a steam plant which was installed in 1903. There are two Jenckes boilers of 70 H.P. each and the safety valves are worn beyond regrinding. They are lever and weight valves of 3½ inches diameter. Can I get new inside parts for them, both stems and seats? They are iron body valves with brass inside parts and there is no maker's name on them. They are a combination valve having a steam pipe connection. Where would you advise sending them for repairs?

Answer.—The repairs necessary can be carried out at any machine shop. It is necessary to draw the brass seats from the body and then turn up new seats to take their place. The brass used should be hard, and free from blow holes. You may find it cheaper to scrap the whole outfit and fit spring loaded valves and this would be more satisfactory. You could probably use the same castings, depending on the construction. The only thing to be absolutely sure of is that there shall be no valve between boiler and safety valves.

SAVING BY HEATING FEED WATER

Question.—What is the saving of fuel by heating feed water?

Answer.—Approximately 1 per cent. for every 10 degrees of heat added to the water. It can be found by the formula

$$\frac{T-t}{H-t+L}\times 100 = \%\text{ saving of fuel.}$$

Where

T = temperature of water leaving heater.
t = original temperature of water.
H = heat of steam in the boiler.
L = latent heat of steam in the boiler.

This is, of course, based on the ratio of the difference between water entering and leaving heater, to the difference between water entering heater and total heat of steam. For instance, to take a simple case, take steam at atmospheric pressure, water entering heater at 60 degrees and leaving at 180 degrees.

Then

$$\frac{180-60}{212-60+966}\times 100$$

$$=\frac{120}{1178-60}\times 100$$

$$=\frac{120\times100}{1118}$$

$$=10.7\%$$

New Truths and Old Fallacies

Hardness of Alloys—*Continued*

The difference in the measurements of the sustaining powers, under pressure, between tin-base copper hardened metals, and lead base metals, free of copper, as shown by tests by the American Society for Testing Materials, is so slight that in some cases it is not more than the breadth of a hair.

In a test, made for us some years ago, Magnolia withstood 19 per cent. greater stress than a Genuine. This test loses some value because we do not know the brand or formula of the Genuine.

In 1912, Professor Robert H. Smith, an eminent mechanical engineer and authority, tested Magnolia against an imitation. In this case Magnolia withstood 16,980 pounds (7½ long tons) per square inch pressure before the test block collapsed. When it is considered that this was a small cylindrical shaped test block, unsupported on the sides to prevent spreading, it is evident how much heavier a strain Magnolia will bear without distortion, when supported in recesses of a shell, and what a large factor of safety it provides.

Professor John Goodman, an equally eminent mechanical engineer and authority, says of Magnolia: "My experience distinctly shows that the higher the pressure applied to a Magnolia Bearing, the better does the wearing surface become." He also says: "I ran a Magnolia bearing for some weeks under a pressure of two tons per square inch, at a surface velocity of 250 feet per minute; the temperature maintained at 130° Fahrenheit, by circulating water through the center of shaft. After the run the surface was perfect, although the lubrication had been meager, viz: 0.002 lbs. of oil on a pad weighing 0.002 lbs."

(Continued next month)

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"New Truths and Old Fallacies"
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THERMOMETER SCALES

Question. — I would like to know through your Power House magazine whether there are any other thermometer scales in use in the world besides the Centigrade and Fahrenheit. If so, please furnish names of them.

Answer. — The three thermometer scales are the Fahrenheit, Centigrade and Reaumur, but the first two are the ones in general use. The Reaumur scale starts at 0 freezing point, boiling point being at 80. The relation between Fahrenheit and Reaumur is as 180 : 80 or as 9 : 4 plus or minus 32 degrees.

A locomotive turn table, 92 feet long, was recently lifted and moved horizontally 1,600 ft. at Kansas in ten hours by means of a 100-ton wrecking crane and two railway flat trucks. The crane first lifted one end of the turn table and a cribbing was built underneath at about two-thirds of its length from the crane. The crane was then lowered away. This action raised the far end and a cribwork was built there. The crane gave another hoist and the first crib was heightened. By repeating this process the turn table was raised high enough to admit the trucks below far more quickly than could have been done with jacks. Once on the trucks the table was easily hauled by a locomotive to its new site.

LUBRICATION AND THE GERM PROCESS

The following is a synopsis of a paper on "Lubrication and the Germ Process," by Henry M. Wells and James E. Southcombe, M.Sc., read at the British Association meeting:

The authors draw attention that the modern view of lubrication on the physico-chemical side is the existence of a residual valency or affinity between the oil and the solid surfaces of the bearing and journal. The problem has, therefore, to be considered as a kind of intimate relationship between the oil and the metal. This is quite a different view to that held by investigators in the past, who thought that the property of "oiliness" so strongly manifested by fatty oils as compared with mineral oils resided in some particular physical characteristic of the oil itself. The modern point of view has been elaborated recently by a number of students of the subject.

The authors have discovered the reason why the fatty or fixed oils possess superior friction-reducing properties to that of mineral oils. They have shown that this is due essentially to the presence in fatty oils of minute quantities of free fatty acids, which are absent in the majority of mineral oils. In consequence of this discovery they have added small quantities (about 1 per cent.) of fatty mineral or organic acids, which are easily accessible and relatively cheap to hydrocarbon oils. The products so obtained possess remarkably low frictional co-efficients. As an example, the addition of 2 per cent. of common fatty acid to a mineral hydro-carbon oil reduces the coefficient of friction shown by this oil on a friction testing machine from 0.0084 to 0.0052—a diminution of 26 per cent.

By suitably choosing the type of fatty acid to be added to mineral oil, the behaviour of oils in the presence of water and other contaminating substances can be modified at will. It is also shown that the risk of metallic corrosion is even less with these oils than the usual compounded oils, because the latter frequently develops in working notable quantities of free acid.

The principle of making mineral lubricating oils possessing increased frictional properties by adding to mineral oils suitably chosen fatty acids in relatively minute amounts has been patented throughout the world, and has been somewhat fancifully called the "germ process," because the fatty acid is the germ of the idea.

The value of the process lies in that oils possessing friction-reducing properties much superior to mineral oils can be prepared at relatively little extra cost to mineral oils. Secondly, by this means an immense quantity of fatty oil suitable for the manufacture of margarine and other foodstuffs is liberated for the country's needs and substituted by a much smaller amount of commercial fatty acids, which are quite unsuitable for food and are more or less in the nature of a by-product.

Finally, it may enable the lubricating oil manufacturer to produce the highest class of friction-reducing oils from comparatively thin — therefore cheaper — mineral oils, and incidentally this may have the utmost significance to-day, when we are striving to foster and develop the mineral oil production of our own country and the Empire.

LOOK WHO'S GOT IT!

There is a growing suspicion that the newspaper reporters have not been interviewing the right parties!

—Des Moines "Register."

IT'S TIME TO DECIDE

what you are going to do about reducing the expense of operation in your boiler-room. The time has gone by when this costly department of your business can be permitted to spend from 10% to 50% more than it should for efficient power production. In most cases this waste has been due simply to neglect on the part of management busy with other and seemingly more important plans for production.

The time has come, however, when costs of operation again must be carefully scrutinized and every needless expense cut to the bone.

There is no department of your business where you can show better results than in your boiler-room.

VULCAN
Soot Cleaners

Many of the largest CENTRAL STATION PLANTS in the country use Vulcan Soot Cleaners to remove the soot and ash accumulations from their boilers. These plants SELL POWER, and they know what it means, in profits and losses, to keep their boilers clean.

Vulcan Soot Cleaners are installed within the boiler setting and operate mechanically. They will save from 4% to 8% of your fuel consumption over hand cleaning, besides doing away with the dirty, disagreeable, time-wasting, hand-cleaning job. With reasonable care and attention they will last indefinitely, and will always return a high profit upon their investment.

You may need other things in your boiler-room, but boiler improvement begins with soot cleaners.

"Spending $796 to Earn $1017.40!"

We have issued an analysis of the cost and earning power of a Vulcan Soot Cleaner, showing that on an average size boiler it will earn more than 127% on its investment. A copy of this analysis will be mailed cheerfully upon request, together with our Bulletin. (Please mention type of boilers in your plant).

The VULCAN SOOT CLEANER COMPANY

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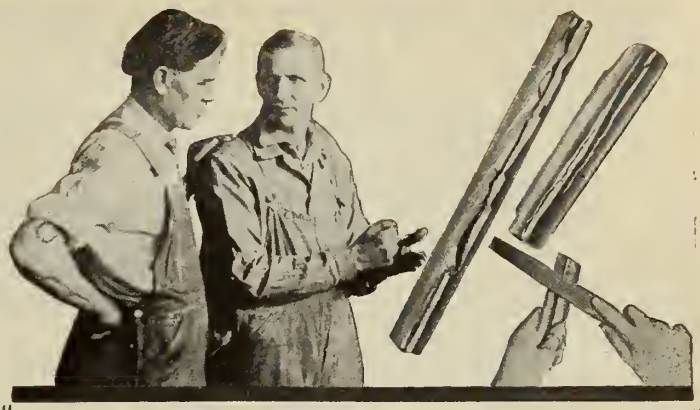

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"You see the Jeffrey people give the Double Bushings of the Jeffrey Carrier a special heat treatment which gives them a hardness akin to glass that is practically immune to wear. But we wanted to be sure that these bushings had the right toughness and resilience to stand the 'gaff.'

"There's no proof so convincing as a practical test. When these bushings stood up without distortion with the gauge reading 37 tons, we were satisfied. Moreover, the ragged fracture shows that the initial toughness is preserved and increased.

"The second test was just as interesting as the first. They tried to gnaw through the outer walls with a sharp file—but nothing doing. It's almost as hard as glass, all right."

The Jeffrey Co. are putting out **Bulletin No. 210-4**, which describes the Carrier completely and tells of the practical tests they made before they were satisfied with the Reliability and Dependability of this Jeffrey Carrier. You'll never regret investing a stamp to write for it.

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1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	30 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$6 50	$6 00
Plates, ¼-in. up	6 00	5 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	28.74
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

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4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 30%.
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IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 30c lb.; class C black, 20c lb.; galvanized, class B, 40c lb.; class C, 30c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.50

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Globe	50
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McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

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Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	19

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	Net
Carriage bolts, 7/16 and up	+10%
Coach and lag screws	—15
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	+10
Machine bolts, ⅜-in. and less	+10
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 50
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 28½
Solder, guaranteed	0 30½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	4 00
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$35 00	$37 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	40 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	43 00	46 00
Copper sheet, planished, 16-oz. base	47 00	50 00
Braziers', in sheets, 6 x 4 base	39 00	42 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	23	Atlas	19
Peerless	22	X Empire	18½
Grand	21½	Ideal	18
Superior	21½	X Press	17
X L C R	20		

Colored

Lion	16	Popular	13
Standard	14	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$45 00	$50 00
Spelter	8 75	10 00
Lead	7 75	9 00
Antimony	8 25	9 00
Aluminum	35 00	35 00

Prices per 100 lbs.

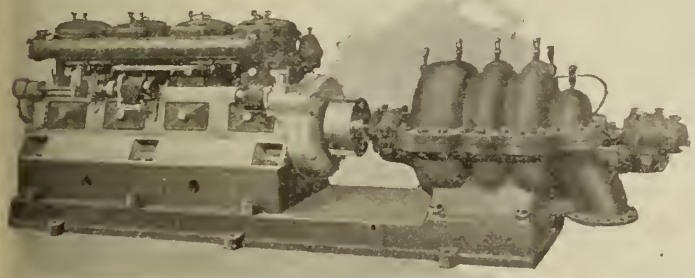
LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

A certain concern dropped one million dollars trying to build the kind of high duty gasoline engine we are offering you for emergency service at $19 per H.P.



Model FC 8-cyl. 200 H.P. Sterling, direct connected to Goulds: 3-stage centrifugal pump, capacity 1,000 G.P.M. against 280-ft. head. To be installed at Gastonia, N.C.

12 to 300 H.P. for emergency service, fire pumps, etc.

May we send literature?

STERLING ENGINE CO.
BUFFALO, N.Y.
Dept. C-4

An Era of Saving
To Follow One of Waste

THE COPES
BOILER FEED REGULATOR

represents one of the smallest items in boiler plant investment. Its purchase price, cost of installation and maintenance expense are negligible when compared with many other items of power plant equipment.

Nevertheless it is one of the most influential factors in saving fuel and promoting the efficiency of labor. It increases the peak load capacity of a boiler plant, promotes safety, and reduces wear and tear on the equipment.

Write for Bulletin D

Northern Equipment Co.
112 West 11th Street
Erie, Pa.

The World's Largest Manufacturers of Feed Water Regulators

Canadian Representatives:
ALLEN GENERAL SUPPLIES, LTD., 205 Yonge Street, Toronto, Ont.
H. N. BROWN, P.O. Box 620, New Glasgow, N.S.
MASON REGULATOR & ENGINEERING CO., LTD., 153 Dagenais St., (St. Henry), Montreal, P.Q.
C. C. MOORE & COMPANY, Engineers, 618 Mutual Life Bldg., Seattle, Wash. (Representatives in British Columbia).
W. W. HICKS & CO., 567 Banning St., Winnipeg, Canada.
Canadian Factory: 191 Barton Street East, Hamilton, Ont.

HOMESTEAD
Quarter-Turn Valves

Use Proves Their Value

When you put **Homestead** Valves up against the hardest services in your plant, then you realize their absolute safety, their strength and durability, that they are constructed to stand greater pressure than that for which they are recommended.

Homestead Valves close with a quarter-turn and remain tight without dripping or leaking. They open with a single quarter-turn of the lever.

Direct and unrestrained flow with simplicity and ease of operation are conspicuous Homestead features.

Elimination of waste and leakage soon pays for **Homestead** Valves.

You should adopt them without delay. Write for catalog.

Homestead Valve Mfg. Company
Homestead, Pa., U.S.A.

Tycos
TEMPERATURE INSTRUMENTS
INDICATING-RECORDING-CONTROLLING

Able instruments, of proved utility, that capably meet every power plant need.

Angle and Straight Stem Thermometers
Recording and Index Thermometers
Hygrometers
Hydrometers
Engine Room Barometers
Pyrometers
Vacuum, Pressure and U Gauges

Ask for catalogs and the advice of our trained engineering staff to help you select the right instrument for each need.

Taylor Instrument Companies
Rochester, N.Y.
110 Church Street, Toronto

There's a *Tycos* or *Taylor* Temperature Instrument For Every Purpose.

729

Good Times Just Ahead

PROSPERITY is within our reach in Canada.

All we need to have and to hold it is a sane, sure grasp on its simple elements.

They are Industry, Integrity, and Faith.

These are the cardinal virtues of human relations. They are the underpinnings of healthy, natural business life and the foundation of a wholesome social system.

They are the fountainhead from which Progress springs. A well-known business economist has called them the "Fundamentals of Prosperity."

Your purchases are an expression of Faith. They are evidence of your Industry. Make them confidently from business institutions of Integrity.

Buying is the backbone of prosperity. An active market means more employment, steadier earnings; benefits are passed around.

Wise spending gives stability to earning and for that reason is far-sighted thrift and sound economy.

The call of to-day is for cheerful thinking, willing working and constructive action by you—everybody—NOW.

To-morrow's change for the better will come about through the combined efforts of each and every one of us.

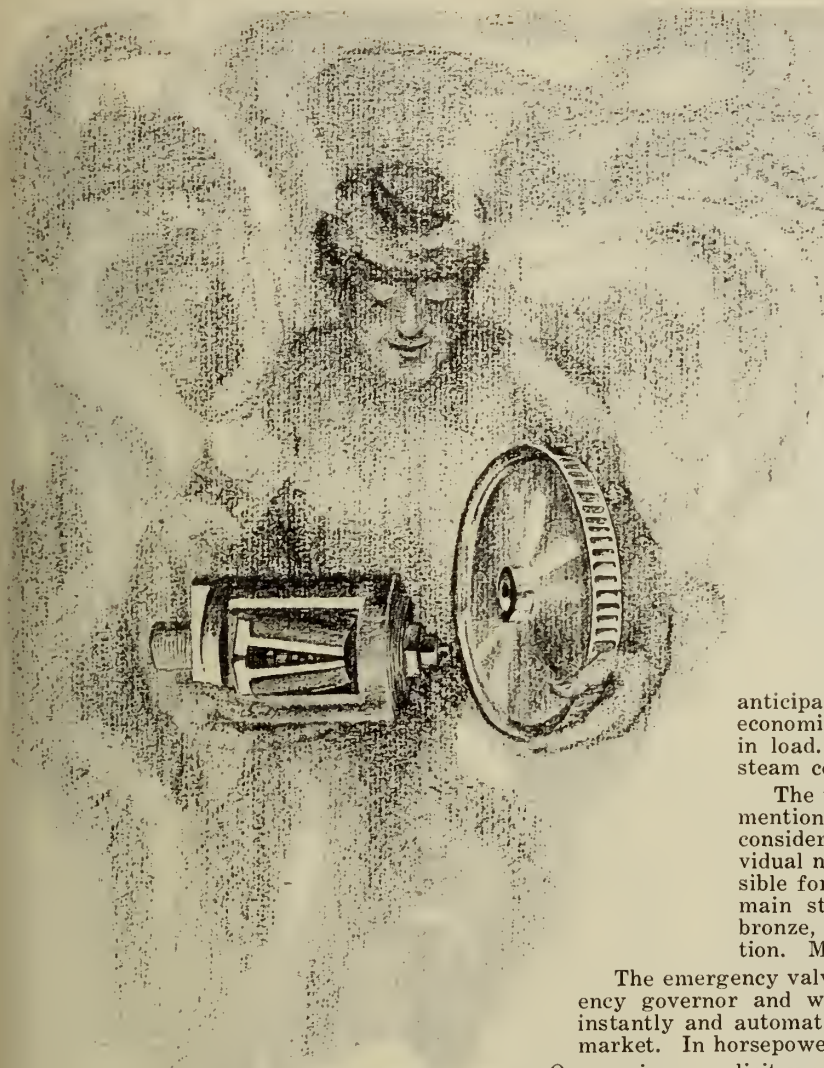
By sheer force of numbers and co-operation, by the high power of heart and mind, we can put Business on a firm, stable basis.

We can do this because all of the material factors making for better business are right.

Let us link our faith with industry, our vision with courage, and forge ahead.

Let's make an uncommon effort toward a common end—Good Times.

A message from the Associated Advertising Clubs of the World.



Sturtevant
(TRADE-MARK.)

TURBINES

Anticipate New Demands for Economy

Demands made to-day of turbines designed for driving fans, blowers, generators and pumps are more exacting than ever before, consequently turbines built to meet requirements of the past, cannot compete with those built for modern conditions.

Sturtevant Type 10 Turbine

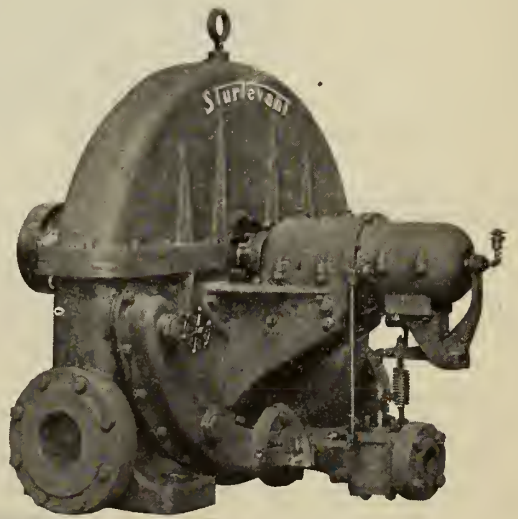
anticipates these ever changing requirements and gives economical and dependable service regardless of the range in load. Continuous operation is assured with minimum steam consumption.

The nozzles and reverse buckets are features worthy of mention when the advantages of Sturtevant Turbines are considered. By simply closing a hand valve each individual nozzle can be cut out of service. This makes it possible for light loads to be carried without shutting off the main steam supply. The buckets are made from tobin bronze, carefully fitted and polished to reduce steam friction. Milled into the rim by our own patented process.

The emergency valve assures reliability. It is connected to an emergency governor and when a predetermined speed is exceeded, closes instantly and automatically. This turbine has been twelve years on the market. In horsepowers from one to five hundred.

Our engineers solicit your correspondence in regard to applying Sturtevant Turbines to your particular needs.

Send for catalog 256N for detailed description of construction.



B. F. Sturtevant Company of Canada, Ltd.

Main Office and Works:
GALT, ONT.

Sales Offices:
TORONTO and MONTREAL

Get Bigger Pay through ELECTRICITY

You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language—complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

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Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Send coupon now—today—and get this great help Library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature_____

Occupation_____

Employed by_____

Residence_____

Reference_____

READER'S NOTICE

Regarding

CHANGE OF ADDRESS

A REQUEST FOR CHANGE OF ADDRESS must reach us at least thirty days before the date of the issue with which it is to take effect. Duplicate copies cannot be sent to replace those undelivered through failure to send this advance notice. Be sure to give your old address as well as the new one.

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

SITUATIONS VACANT

ENGINEER QUALIFIED TO TAKE CHARGE of Saw Mill Power Plant; only competent man need apply; duties to commence immediately. Apply Box 24121, "Power House." (pfh)

WANTED AS ASSISTANT EDITOR, ON group of technical papers, live-wire mechanical engineer. Qualifications required are: Age, under 45, good education, certain amount of practical experience, ability to express ideas on paper, good mixer and aggressive worker. Splendid opportunity for the right man. State full particulars in first letter, mentioning present salary. Box 200, Power House.

EMPLOYMENT DESIRED

ENGINEER-MILLWRIGHT, 3rd CLASS, MARried. Wants position. References. Apply Box 201, Power House. (pfh)

STATIONARY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers. Corliss and all classes of stationary engines, compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St., Toronto.

MACHINIST WITH DRAUGHTING EXPERIence, wants work of any kind. N. Ryckman, No. 174372, 5 Foxley St., Toronto. Phone Parkdale 3254w. Mention "Power House." (pfh)

MECHANICAL ENGINEER, 29, FIRST-CLASS stationray engineer's license for Ontario, 10 years' power plant experience, saw-mill and paper mill; specialist in making repairs and operating plant economically, desires permanent position with large saw-mill or paper mill, preferably in New Ontario. Apply to Box 202, Power House.

BELTING

LEATHER AND RUBBER BELTING, USED, but in good condition; at about half new price. Apply, mentioning "Power House," to Tarshis & Sons, 400 Front St. East, Toronto. (p.f.h.)

WE HAVE A QUANTITY OF NEW RUBBER belting to sell at less than half price; will ship C.O.D., subject to inspection; new circular saws, good second-hand leather and rubber belting, wire cable, vises, chain blocks, garden hose, steam hose, rubber packing; send us your requirements; our quotations will surprise. Apply, mentioning "Power House," to The York Belting Co., 115 York St., Toronto, Ont. (p.f.h.)

EQUIPMENT

BOILER FOR SALE—CAPACITY 150 H.-P., horizontal tube, size 72" x 16' long; working pressure 110 lbs. steam; Government inspection certificate. Apply, mentioning "Power House," to the Steel Company of Canada, Ltd., Canada Works, Hamilton, Ont. (pfh)

STEEL TANKS, STACKS, PUMPS, CONDENSers, steam engines, boilers, heaters, transmission and elevating machinery, safes, vaults and vault doors; catalogues and specifications sent on request. Apply, mentioning "Power House," to The Goldie and McCulloch Co., Limited, Galt., Ont. (p.f.h.)

GRATE BARS

ALL STYLES TO ORDER PROMPT DELIVery. The E. T. Lansdowne Foundry Co., 37 Niagara St., Toronto. Mention "Power House." (p.f.h.)

Like Paying a Thief to Rob You—

Just imagine, if you can, going out into the street and saying to a thief, "Dear, kind Mr. Thug, please rob me. And here is fifty dollars for doing the job." Can you see yourself doing it? Certainly not—

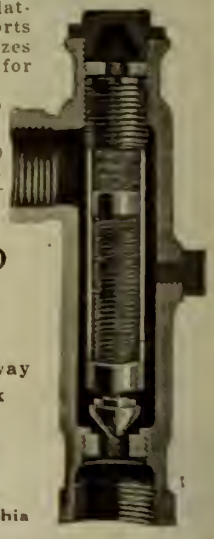
—and yet there are some concerns that pay good money for an old-fashioned "bucket" or "float" type steam trap that starts to rob them the minute it is installed! Robs them through inefficient operation by passing steam—by permitting condensate to collect and cool in large volume, thereby wasting valuable heat units by getting out of order and creating heavy repair bills.

Sensitive to a marvelous degree, the Sarco expansion element opens the valve and allows all condensate to drain off the minute it collects. No chance for it to get cool and waste heat units before being returned to the hot well.

Having no levers, floats, washers or other parts to get "out of whack" easily, it stays on duty year after year, without a cent's worth of repairs.

And—here is a feature you can't ignore—this highly efficient trap that saves you money after it is installed costs only one-third as much as the "bucket" or "float" type trap.

Installed in double-quick time on any line, without platforms, supports or pits. Sizes ⅜ to 3 in., for any given pressure up to 200 lbs.



Sold on 30 days' trial. Write for Catalog J-12.

SARCO CO., INC.

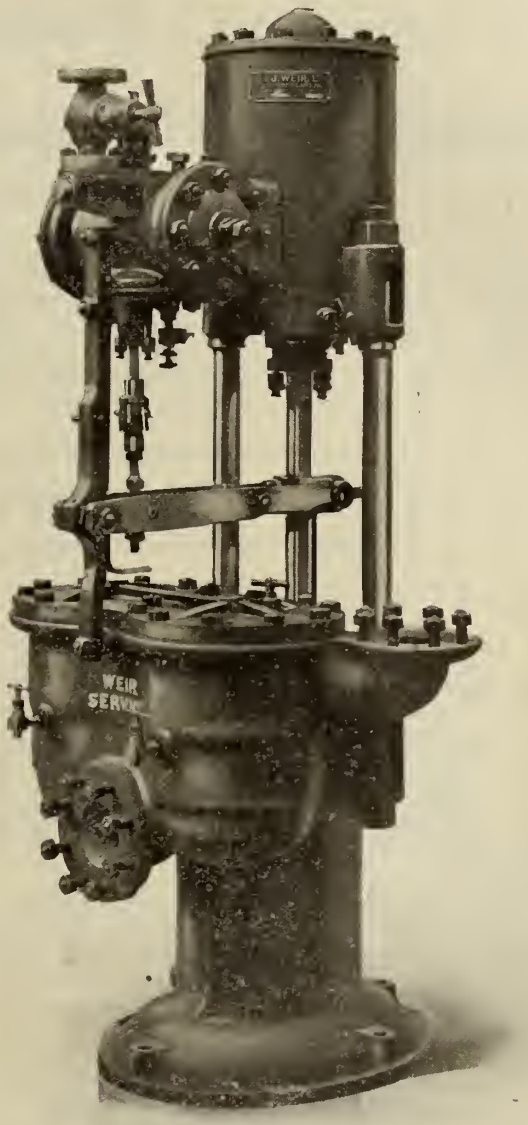
239 Broadway
New York

Buffalo
Chicago
Cleveland
Detroit
Philadelphia

STEAM TRAP SARCO

Weir Products

Single Acting Simplex Feed Pumps
Turbine Rotary Feed Pumps
Compound Feed Pumps
General Service Pumps
Direct Contact Heaters
Multiflow Heaters
Evaporators and Distillers.



Built to Absolute Standards

EACH part of every Weir power plant auxiliary is built to an absolute standard. This guarantees uniform results from all products and also enables repairs to be made with as little delay as possible.

The value of facilities for making quick repairs can hardly be over-emphasized. Consider these features of Weir Products when purchasing power plant auxiliaries.

Special attention is paid to the prompt dispatch of goods and the routing and shipment of all consignments. Special instructions in this regard always receive our most careful attention.

Prompt and careful shipment is but a single phase of Weir Service. To serve our customers in every way to the best of our ability is our aim.

G. & J. WEIR (CANADA) LIMITED

Sales Engineers

PEACOCK BROTHERS, LIMITED, MONTREAL

Of Interest to Every Canadian

Number One of a Series of Advertisements

Efficient service is the keynote of membership of

Power House

—IN—

Canadian National Newspapers and Periodicals Association

—a highly constructive service—absolutely dependable and devoid of prejudice and personal bias. It means much to you!

The policies and principles back of this important service enable you to secure practical and impartial information of great value in business and in the home: and they assure a ready fund of literature of exceptionally high standard at all times.

To read the Association's Standards of Practice listed herewith is to understand what this Association means to you.

Standards of Practice

Canadian National Newspapers and Periodicals Association

THE Members of this Association shall dedicate their best efforts to the cause of business, and public service, and to this end shall pledge themselves:

1. To consider first the interests of the Subscriber.
2. To work for truth and honesty in all departments.
3. To eliminate, in so far as possible, their personal opinions from their news columns, but be leaders in thought in their editorial columns, and make their criticisms constructive.
4. To refuse to publish puffs, free reading notices, or paid write-ups, to keep their reading columns independent of advertising considerations, and to measure all news by the standard "Is it real news?"
5. To decline any advertisement which has a tendency to mislead, or which does not conform to business integrity.
6. To solicit subscriptions and advertising solely upon the merits of the publication.
7. To supply advertisers with full information regarding character and extent of circulation, including detailed circulation statements, subject to proper authentic verification.
8. To co-operate with all organizations and individuals engaged in creative advertising work.
9. To avoid unfair competition.
10. To determine what is the highest and largest function in the field which they serve and then to strive, in every legitimate way, to promote that function.

This is Number One of a series of advertisements regarding an Association that typifies thorough-going Canadian stability. Read the forthcoming advertisements in Magazines, and Agricultural, Business, Religious and Educational newspapers, and Technical newspapers.

Canadian National Newspapers and Periodicals Association

Office - 70 Lombard Street - Toronto, Ontario

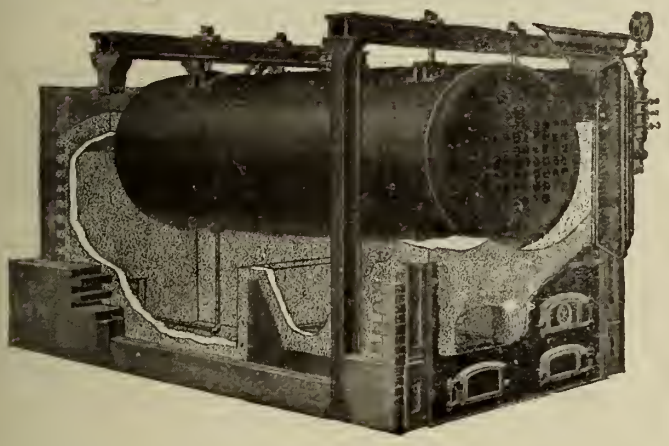
BUILD YOUR NEXT BOILER FURNACE LINING LIKE THIS

With Betson's Plastic Fire Brick it is easy for anyone, even without experience. No special forms or tools are necessary to lay up a one-piece, jointless furnace lining that is air and gas tight and free from the destructive effects of gases getting back of the fire brick lining, or expansion and contraction. No separate fire brick, tiles or blocks, and no clay mortar joints to give way.

Write for informing pamphlet.

Betson Plastic Firebrick Co., Inc.
P. O. Box 386-6 - Rome, N.Y.

Canadian Distributor:
International Chemical Co.
44-6 Lombard St., Toronto, Ontario, Canada



GATES
REFRACTORY LININGS

A Size for Every Purpose

NO matter what size or shape of furnace lining you require, there's a Gates Product that will fill the bill.

Gates Refractory Linings are made from the highest grade refractory material. They are known for their ability to stand up under the most severe service.

We are specialists in **Boiler Setting, Furnace Building,** and all kinds of **Power Plant Brick Work.** Experts on repair work. Let us quote.

Gates Refractories
LIMITED

382 St. James St. MONTREAL

The ANDERSON
PRESSURE OIL FILTER

Look up your yearly oil consumption figures; consider the ever-increasing prices of oil and the fact that you can save at least one-half of every bill by the use of an Anderson Pressure Oil Filter.

By collecting the waste oil in drip pans, properly located beneath the engine or machinery, and running it through the Anderson Filter you cut your oil bills in half.

In the Anderson the used oil undergoes a cleansing treatment identical to that of the refiners. It comes from the Filter clean and suitable for use on the finest bearings.

The Anderson is an economy too great for you to overlook. Write to-day for catalog.

The V. D. Anderson Co.
1935 W. 96th St. - Cleveland, Ohio

HINTS TO BUYERS

Godfrey Conveyor Co.

127-147 Thirteenth Street, ELKHART, Ind., U.S.A.

Originators, Patentees and Manufacturers of

CONVEYORS

operating Gravity - Filled Bottom Dump Bucket by Monorail or Cableway.

Canadian Office:

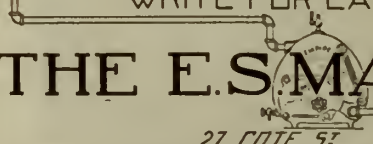
M. A. KENNEDY, LIMITED
TORONTO, CANADA
106-110 Richmond St. West Phone Adelaide 7511

DARLING BROTHERS, LIMITED

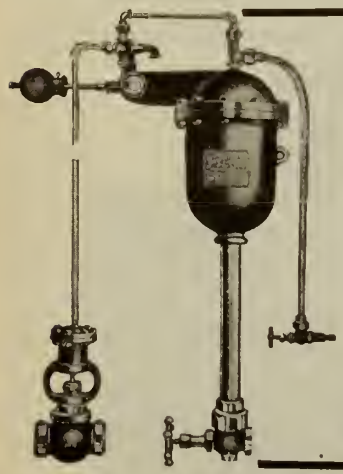
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE



THE E.S.MANNY Co
27 COTE St MONTREAL, QUE



Safety or Worry? CHOOSE

Would you rather worry about your fireman's inattention to the boiler feed water, or be absolutely assured of continuous middle gauge lever control by VIGILANT FEED WATER REGULATORS?

We will gladly furnish full information.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor.

LADD WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

THE GEORGE T. LADD COMPANY
First National Bank Building
PITTSBURGH - - PENN., U.S.A.

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

When Writing Advertisers Please Mention This Paper

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

CRANE MALLEABLE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

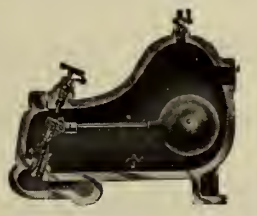
BRANCHES: Toronto, Winnipeg, Vancouver
SALES OFFICES: Haifax, Quebec, Ottawa, Calgary

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



Send for Catalogue

THE GARTH COMPANY
26 Craig Street - MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes

Trial Orders Solicited—Our Packings Do the Rest

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED
LONDON LIVERPOOL CARDIFF, ETC.

Canadian Representative
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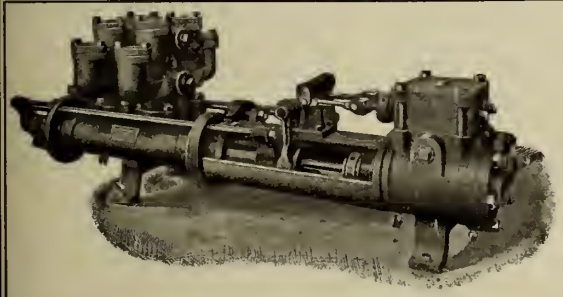

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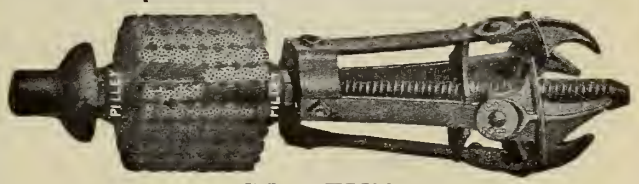

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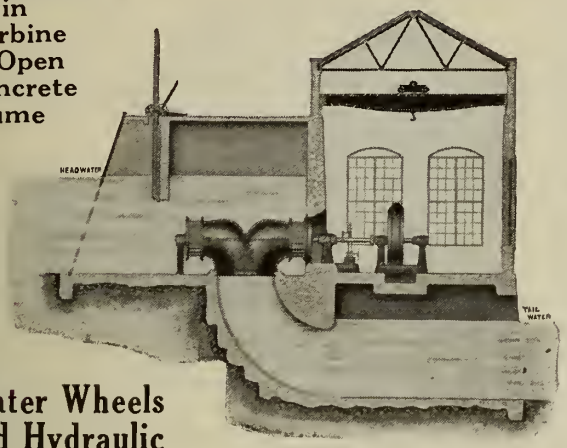

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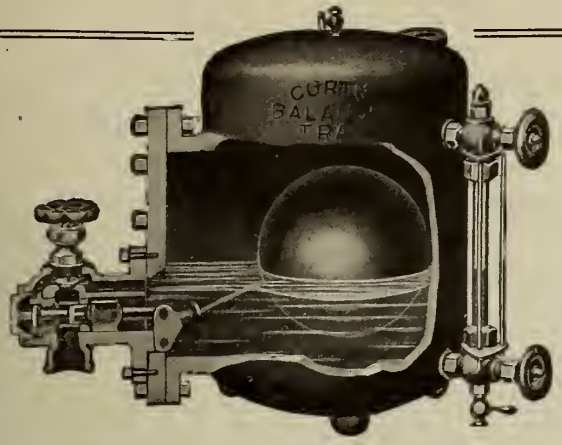

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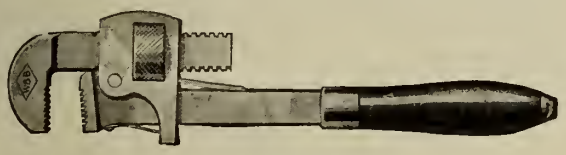

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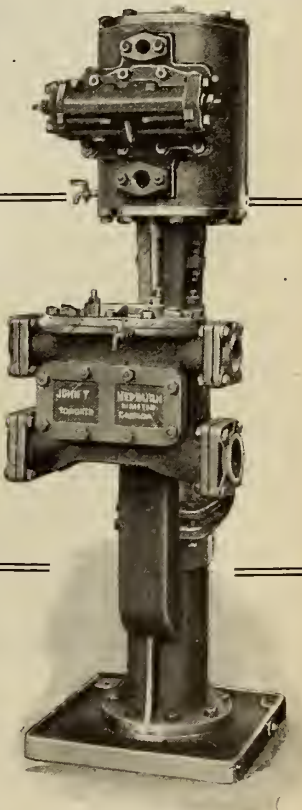

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Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Paper Co., Ltd., Montreal.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal Que.
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Jeffrey Manufacturing Co., Montreal.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal,
Green's Economiser, Ltd., Toronto.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co. Windsor Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal Que.
Arthur S. Leitch Co., Ltd., Toronto.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Lunkenheimer Co., Cincinnati, O.
Jas Morrison Brass Mfg. Co., Toronto.

EXPANSION BOLTS
Beveridge Paper Co., Ltd., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London Ont
Pratt & Cady Co., Inc., Hartford, Conn
Robb Engineering Works, Ltd. Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto

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Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

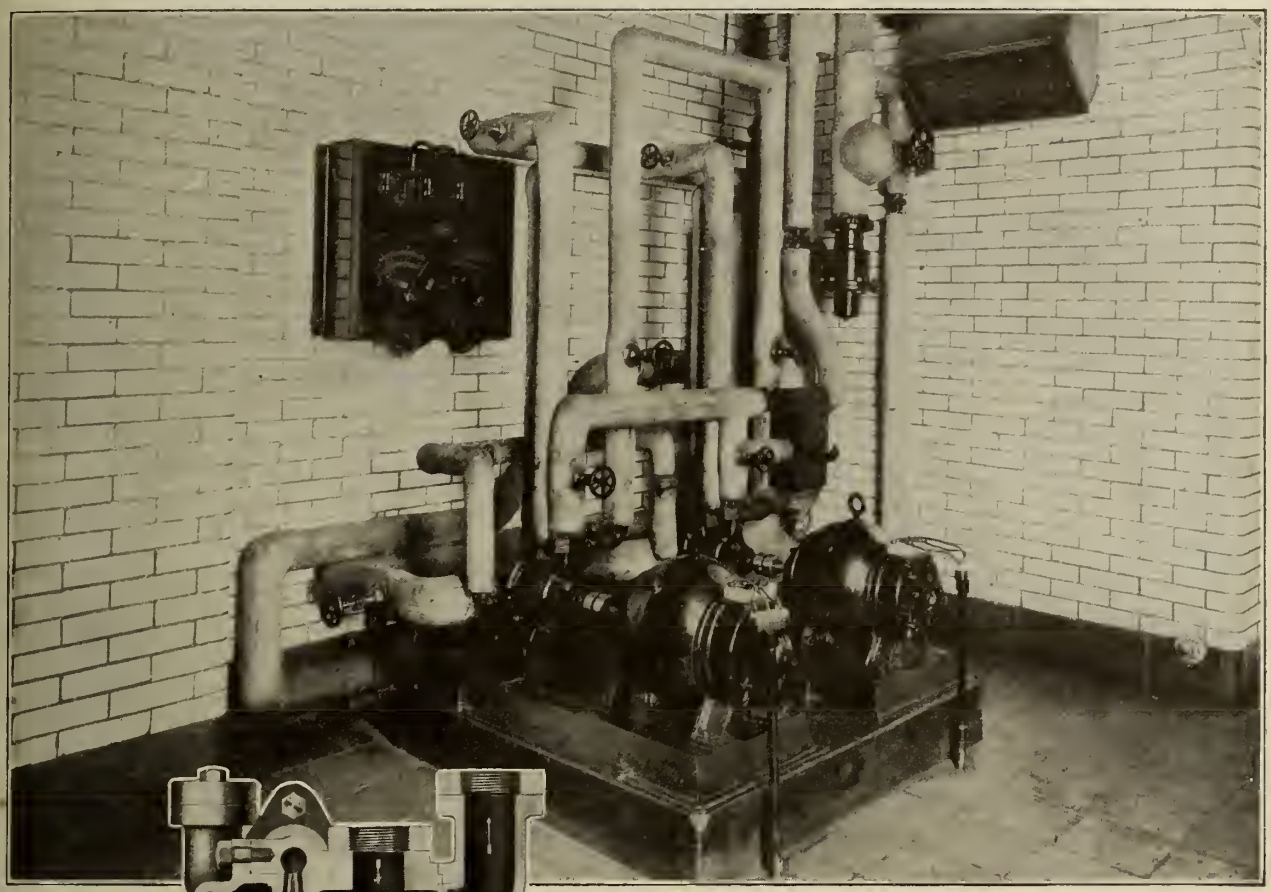
FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England

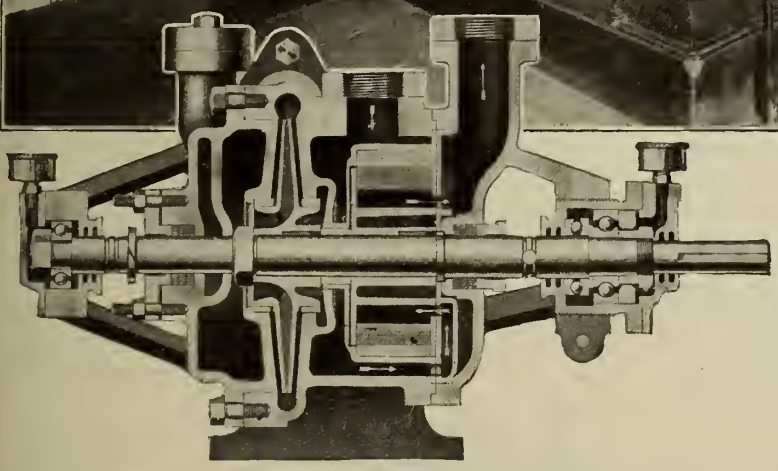
FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd. Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Mackinnon Steel Co., Ltd., Sherbrooke
E. J. Phillip & Sons, Toronto
Scaife & Sons, Wm. B., Pittburgh, Pa
York Mfg. Co., York, Pa

EFFICIENT HEATING *demands the* JENNINGS PUMP





Duplex "C" Unit, Automatic Operation

Combined capacity 52,000 sq. ft. direct radiation. Each pump has an air capacity of nineteen cubic feet per minute in addition to a water capacity of thirty-five gallons per minute.

The motors are only two horse power.

THE Jennings Pump consists of two independent turbine units, an air pump and a water pump. As each material is handled separately, the boiler pressure is against the water only. The air and vapor, approximately four-fifths of the volume handled, are delivered to atmosphere without back pressure. The saving in horse power is over fifty per cent.

Because of its compact design, this equipment can be installed in less than one-third the space necessary with other apparatus. All interior parts are bronze, supported on annular ball bearings mounted outside of casing. Moving parts revolve without contact.

There are many other reasons why the Jennings is being installed on practically all of the big jobs. Bulletin No. 8 gives them in detail. Write for it.

THE ARTHUR S. LEITCH CO., LIMITED

1001-2 Kent Building, TORONTO, ONT.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
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Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Paper Co., Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK, PLASTIC
Beveridge Paper Co., Ltd., Montreal.
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Paper Co., Ltd., Montreal.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Paper Co., Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jafferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Karr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
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FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

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Can. H. W. Johns-Manville Co., Toronto.

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Bailey Meter Co.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

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Jos. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.
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Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Roma, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

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Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holdan Co., Limited, The, Montreal.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co. Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holdan Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp. Michigan City, Ind
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

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Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equip. Co., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toro

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Qu
Waterous Engine Works Co., Brantfor

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toror
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limite

HOSE, WATER, STEAM AND A
Gutta Percha & Rubber Co., Limite

HOSE, STEAM, SUCTION AN WATER
Can. Fairbanks-Morse Co., Ltd., Mont
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., L Montreal.
Pratt & Cady Co., Inc., Hartford, Co

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATOR
Smart-Turner Machine Co., Ltd., Hamil

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., L Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.,
MacGovern & Co., Inc., Montreal, Qu

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norw Con.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., L Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.,
Linde Can. Refrigeration Co., Montr
Norwalk Iron Works, S. Norwalk, Co
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—AI TYPES
Schaeffer & Budenberg Mfg. Co., Bro lyn, N.Y.
Uehling Instrument Co., New York, N

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Mont
Can. H. W. Johns-Manville Co., Toror
Green's Economiser, Ltd., Toronto, O
Uehling Instrument Co., New York, N

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, On

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, O
Taylor Instrument Co's., Rochester, N
Yarnall-Waring Co., Philadelphia, P

INSULATING BRICK
Armstrong Cork & Insulation Co., M treal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toror

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toror

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toror
D. K. MacLaren, Ltd., Montreal, Qu

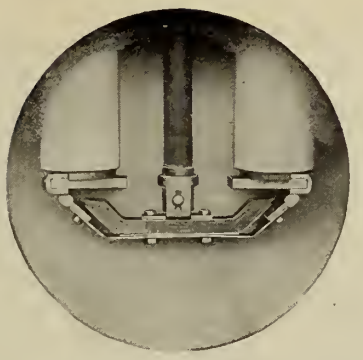
LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montr
Can. H. W. Johns-Manville Co., Toror

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montr
Can. H. W. Johns-Manville Co., Toror

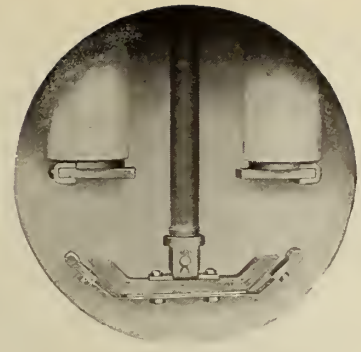
LIGHTING FIXTURES, STREE
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

Closed



Arcing Tips Protecting Brush



Open

Circuit Protection Insured by Condit Oil Switch Construction

The laminated brush contacts give perfect wiping contact when closing the switch.

The auxiliary arcing tips finally break the circuit, avoiding arcing from main contacts.

Very liberal clearance is provided when the switch is fully opened.

The tank-per-pole arrangement of the Condit D13 Oil Switch illustrated below gives a high factor of safety.

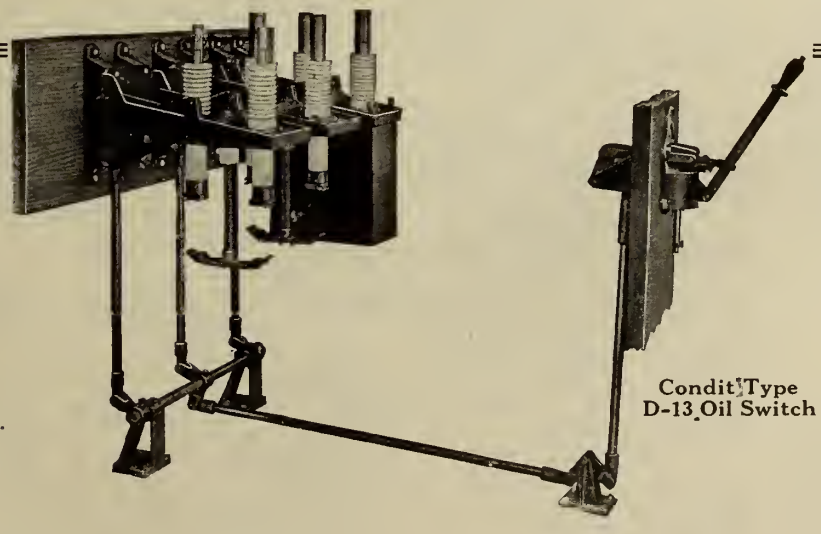
This switch can be furnished in ratings up to 800 amperes at 15,000 volts, or 300 amperes at 27,000 volts.

Ask for information on the new Condit Double Tank construction, a most important new development in oil switch construction, giving greatly increased rupturing capacity.

Our nearest house will gladly furnish complete information on Condit Oil Switch construction and protection.

Northern Electric Company
LIMITED

Montreal Halifax Quebec Toronto London Winnipeg Calgary Vancouver
Ottawa Hamilton Windsor Regina Edmonton



Condit Type D-13 Oil Switch

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW (Air, Gas, Steam, Water)
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
Republic Flow Meters Co. of Canada, Toronto, Ont.
The Mason Regulator & Eng. Co., Ltd. Montreal.
Yarnall-Waring Co., Philadelphia, Pa.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co. Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

PACKING, ENGINE
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Bolco Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Bolco Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Bolco Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Bolco Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Bolco Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Bolco Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Bolco Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Bolco Supply, Ltd., Toronto.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Hort Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane'a Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufactnring Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

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Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lind
Darling Brothers, Ltd., Montreal, Qu
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamil

PUMPS
Mason Reg. & Eng. Co., Ltd., Montr
Coppus Eng. & Equipt. Co., Worces
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Cr
Can. Fairbanks-Morse Co,. Ltd., Montr
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, C
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamil

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montr
American Steam Pump Co., Battle Cr
Boving Hydr. & Eng. Co., Ltd., Lind
Coppus Eng. & Equipt. Co., Worces
Can. Fairbanks-Morse Co., Ltd., Montr
Can. Steam Boiler Equipt. Co., Toro
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London, O
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamil

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lind
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE CURB
S. F. Bowser Co., Ltd., Toronto, On

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Cr
Boving Hydr. & Eng. Co., Ltd., Lind
Coppus Eng. & Equipt. Co., Worces
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Mason Reg. & Eng. Co., Ltd., Montr
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton
Waterous Engine Works Co., Brantf

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Cr
Darling Brothers, Ltd., Montreal, Que
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montr
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Co
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montr
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Linde
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLIN
S. F. Bowser Co., Ltd., Toronto, O
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUNI
American Steam Pump Co., Battle Cre
Can. Fairbanks-Morse Co., Ltd., Montr
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSU
American Steam Pump Co., Battle Cre
Boving Hydr. & Eng. Co., Ltd., Linde
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Cre
S. F. Bowser Co., Ltd., Toronto, O
Can. Detroit Lubricator Co., Walkervi
Lunkenheimer Co Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, POWER
American Steam Pump Co., Battle Cre
Boving Hydr. & Eng. Co., Ltd., Linde
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Co
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantfo
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montre
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que
Pratt & Cady, Hartford, Conn.

Growth of Utility Service Calls for Superheated Steam

UTILITY operation costs have increased. The growth of utility service has been insufficient to meet the necessities of the public and of industry. Expansion of utility service, while necessary, will involve additional power, and power will require fuel. A still further demand will be made on our diminishing fuel resources.

Only by the utmost conservation can expansion in service be realized. Superheated steam, correctly applied, plays a vital part in making possible both expansion and conservation, because for its first cost it renders higher net returns on the investment than any other means known or practised to obtain economy.

Elesco Superheaters are specified by discriminating engineers.

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TRANSPORTATION BUILDING,
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Works at SHERBROOKE, QUEBEC

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all Purposes.

ELESCO

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Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal,
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
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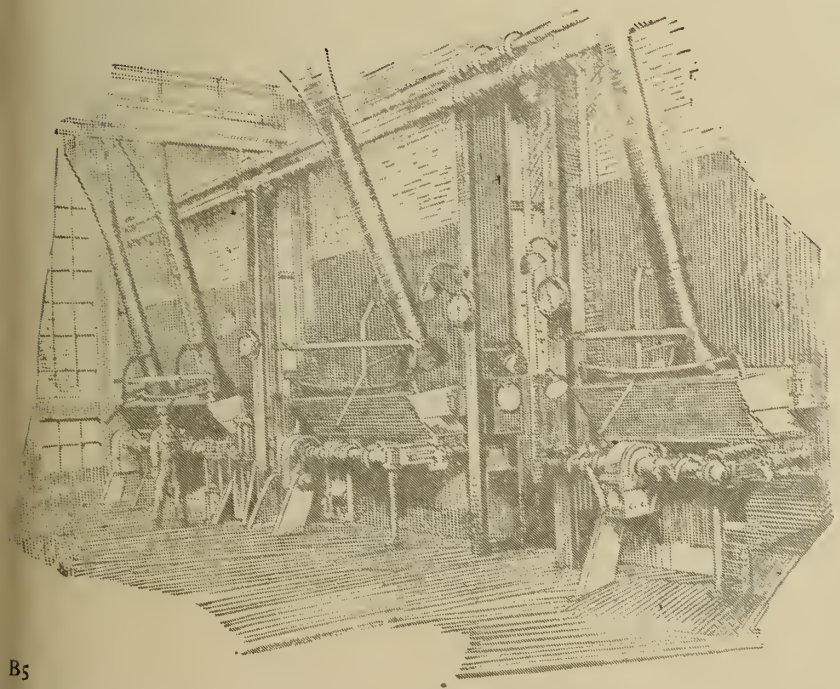

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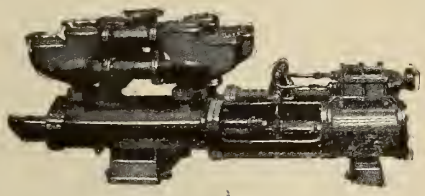
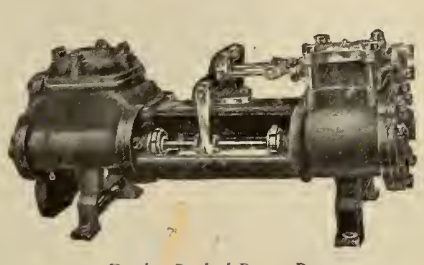
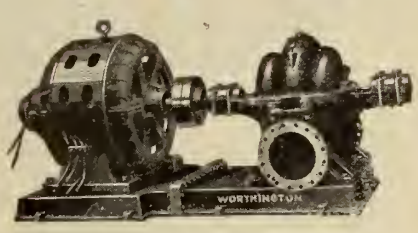


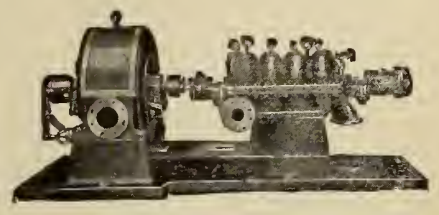
Pot Valve Boiler Feed Pump



Duplex Packed Piston Pump



Split Casing Double Suction Volute Pump



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Centrifugal pumps often become steam bound while handling hot water. Under such conditions the rotating element of the average pump may seize at close clearance points. Worthington double suction centrifugal boiler feeder is equipped with a special floating sealing ring device which prevents this binding.

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A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

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ol. XIV.—No. 5. Publication Office, Toronto—March 5, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

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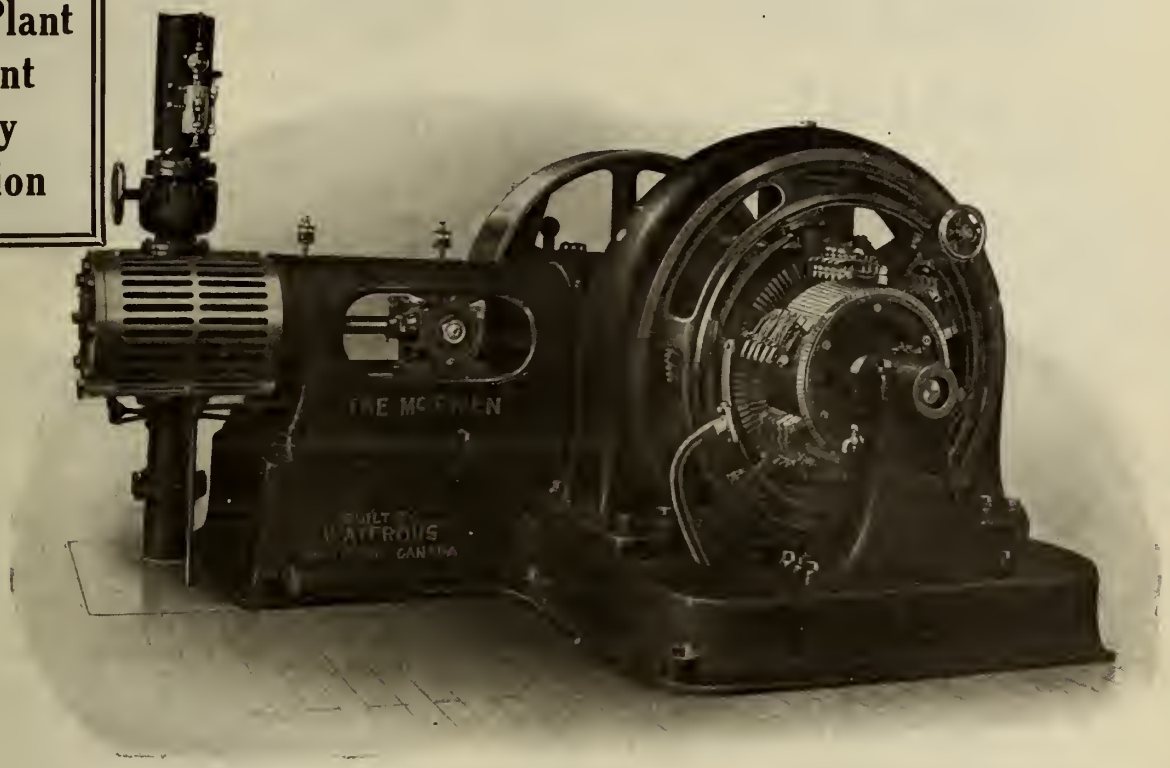

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PLIBRICO is shipped only in steel containers of distinctive appearance. Warehouse stocks carried in all principal cities. Write for book on Furnace Building.

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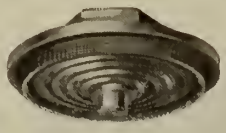
The Dunham Radiator Trap maintains a radiator at its maximum heating efficiency by permitting the passage of all air and water from the radiator and holding all steam within the radiator until it gives up its heat.

Complete data on request



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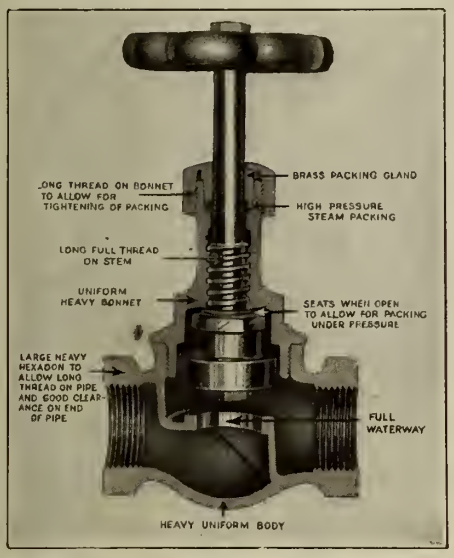
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UNIFORM HEAVY BONNET
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LARGE HEAVY HEXAGON TO ALLOW LONG THREAD ON PIPE AND GOOD CLEARANCE ON END OF PIPE
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HEAVY UNIFORM BODY

A-840

This is a strictly high-grade valve throughout. It is made of steam-metal, rigidly inspected and factory tested to withstand any pressure up to 175 pounds.

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This valve has given excellent satisfaction on all kinds of steam works and is highly recommended by engineers.

We can supply guaranteed valves of all kinds promptly. They are also carried by leading jobbers everywhere. Write us in detail regarding your needs.

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You know it's Right."

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LONDON AND TORONTO, CANADA

New Truths and Old Fallacies

Hardness of Alloys—*Continued*

Referring again to the test made by Professor Robert H. Smith, concerning the hardness of Magnolia, he said: "The longer the Magnolia bearing is used, and the more severe the duty imposed on it, the better becomes its condition."

When these tests were made by Professors Smith and Goodman, it is questionable whether either of them had considered the fusibility of alloys as affecting the values, but Professor Smith specifically says that he found Magnolia much superior to either Babbitt (Genuine) or Gun Metal (bronze).

The mention of bronze reminds the writer of an incident related to him by Mr. F. L. Johnson, once Associate Editor on "Power" and previously for many years a practical operating manager of large plants. When he was in charge of the Baltimore Copper Works a delay occurred in delivery of bronze bearings for the rolls. Without consulting him a supply of Magnolia was sent to tide over this critical period.

As there was no help for it, he poured the Magnolia bearings and then waited around for the expected trouble. To his great surprise the Magnolia lined bearings ran cool and far surpassed the bronze bearing in wear, and from that day he never used any metal on any bearings other than Magnolia, when he could get it.

Such demonstrations of Magnolia's capacity to sustain heavy loads and without injury, do not happen from chance. Magnolia is not only sufficiently hard, but is protected by its other qualities from heating and rapid wear on bearings, which are destructive to most babbitts.

Magnolia also favors adjustment to any inequalities of bearing or shaft, thereby distributing the load uniformly over the entire surface.

(Continued next month)

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OF CANADA, LIMITED
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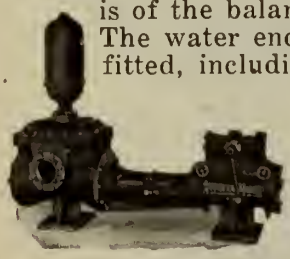
AMERICAN-MARSH PUMPS

SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—
Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

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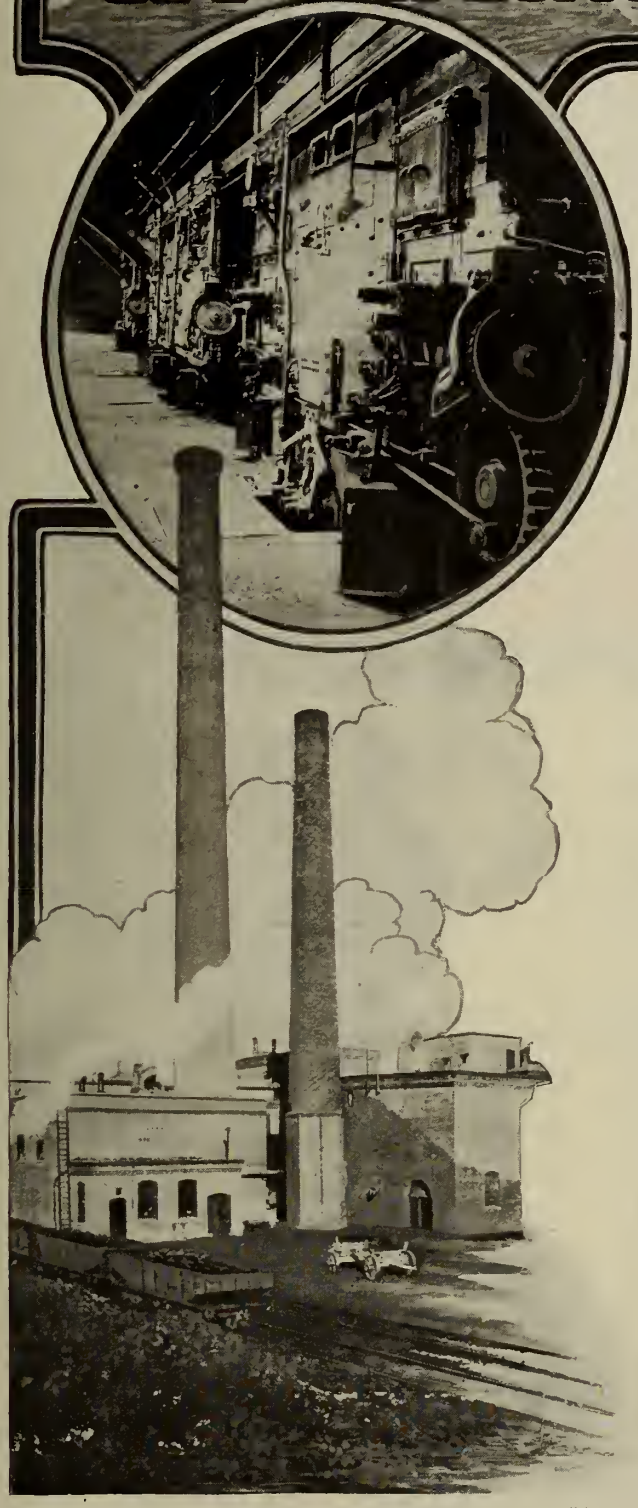
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London, Ont. Gorman, Clancy & Grindley, Limited, Edmonton, Calgary and Vancouver.

722 MURPHY FURNACES installed in 114 PAPER AND PULP MILLS



Pushing ahead from a single installation of one stoker under a 150 HP boiler in 1884, to 722 furnaces under boilers totalling over 200,000 HP today and installed by 114 different paper mills is the record of

MURPHY AUTOMATIC FURNACES

This fact has a significant meaning to every paper mill manager interested in power generation and gives you an idea of the success attained by the Murphy in this field.

Located as many paper mills are, in isolated places where breakdowns are more than ordinarily expensive, unfailing reliability is an essential factor.

Forty-four years of careful attention to Murphy design and development assures this reliability to an unusual degree.

In addition, the Murphy record for pounds of paper produced to coal used—for efficiency—for labor saving—for cleanliness—makes it the choice of such a large number of the leading paper mills of this country.

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The Heart of Your Power Plant

is the boiler room and there's where all efforts to cut down factory costs must begin. And that is also the place and the reason why you should use

BETSON'S

REG. U.S. TRADE MARK PAT. OFF. PLASTIC FIRE BRICK

the one-piece furnace wall lining and brickless arch material.

Line your furnace with Betson's Plastic Fire-Brick instead of old-fashioned brickwork which invariably cracks and crumbles and lets in cold air. Then your walls will endure for years rather than a few months; and they'll be free from leaks and cracks, a seal against cooling currents of air.

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44-6 Lombard St., Toronto, Ont., Canada

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Bronze To Bronze At The Joint

"Dart" Service
Means
Long Service

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Specify Dart Union pipe couplings in your next jobbers' order

MANUFACTURED ONLY BY
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Toronto, Ontario.

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1500 lb. Hydraulic Pressure

And not a pound wasted if joints are packed with Vulcabeston Red Fibre Sheet Packing.

Strong, long fibres of asbestos in an impervious binder give the resiliency and life that insure tight joints.

VULCABESTON
RED FIBRE SHEET PACKING

is too strong to squeeze out like ordinary compressed asbestos sheet; unlike rubber the binding does not harden or disintegrate.

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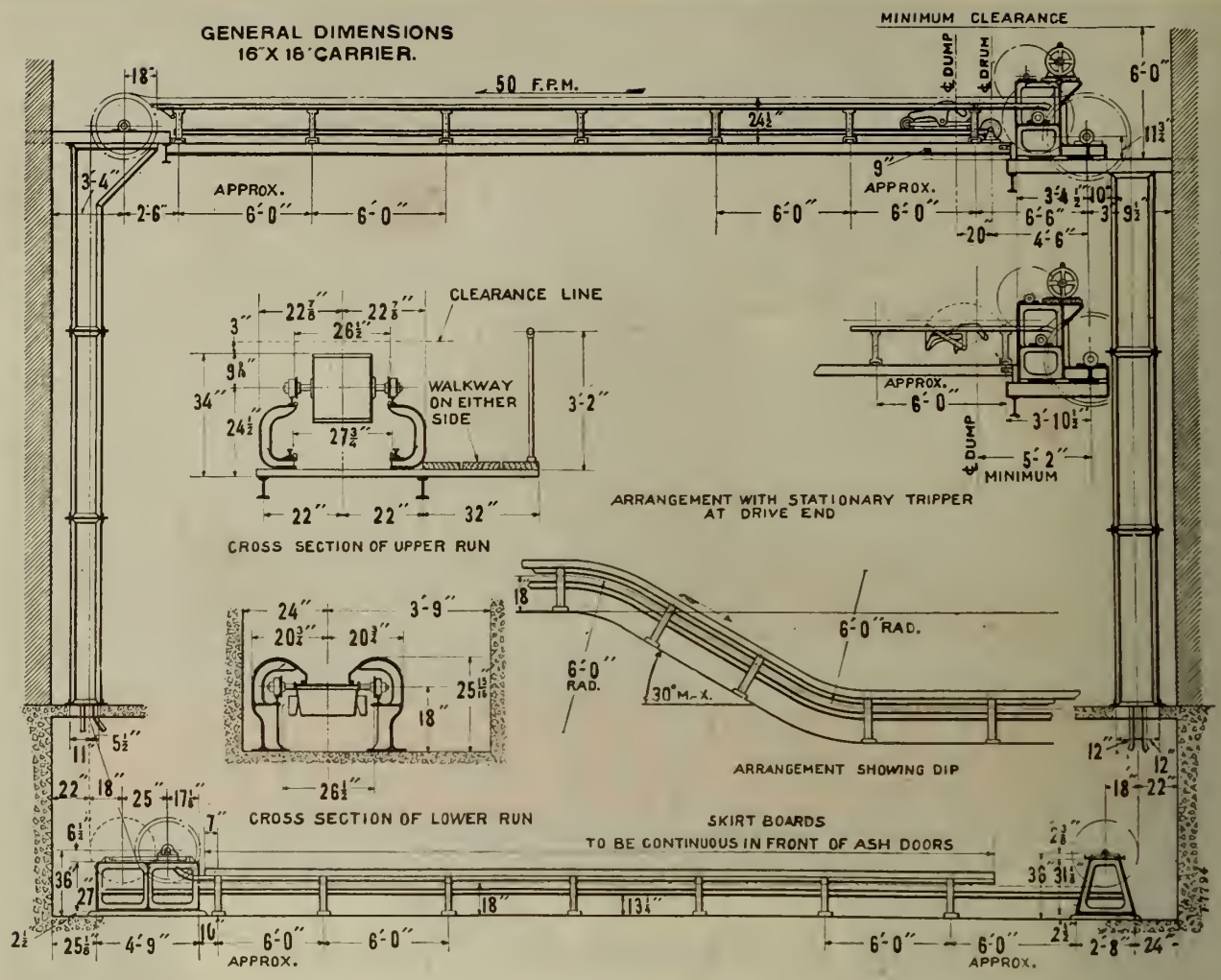

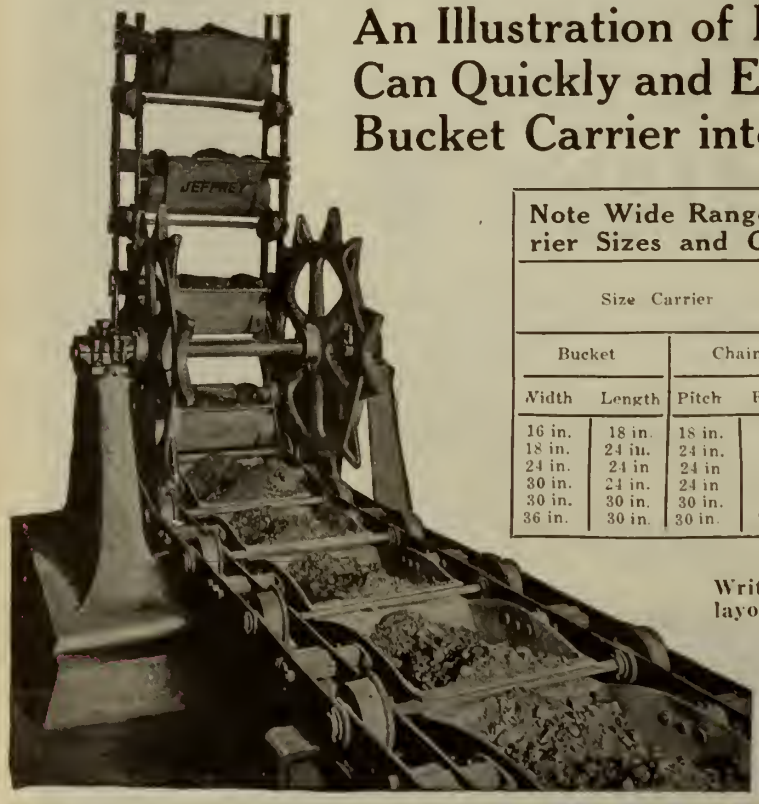

An Illustration of How Architects and Engineers Can Quickly and Easily Place the Jeffrey Pivoted Bucket Carrier into Their Building Plans

Note Wide Range of Carrier Sizes and Capacities

Size Carrier				Tons per Hr. Coal 50 lb. cu. ft. Speed 50 F. P. M.
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Width	Length	Pitch	Roller	
16 in.	18 in.	18 in.	5 in.	30
18 in.	24 in.	24 in.	6 in.	50
24 in.	24 in.	24 in.	6 in.	70
30 in.	24 in.	24 in.	6 in.	85
30 in.	30 in.	30 in.	7 in.	135
36 in.	30 in.	30 in.	7 in.	160

A glance at the above drawing—a typical page from our catalog, will convince you that we can help you in your designing work by indicating the vital dimensions necessary to properly install the Jeffrey Pivoted Bucket Carrier—thus saving you Time, Labor and Correspondence.

Write for Catalog No. 210, with its many blueprints of typical layouts, shop views and photographs of actual installations.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms
MONTREAL

FROM ARCTIC COLD TO SUPERHEAT

To withstand the wide variations of temperature and severe conditions of ice machine service, a special ammonia packing is necessary.

A packing failure in a plant having reserve compressors might merely result in ammonia loss, while in a smaller plant running at "peak load"—a shut-down due to inferior packing could result in a loss far exceeding the cost of a special high grade packing. Garlock Style No. 449 is a packing set specially designed for service on ammonia compressor rods—years of successful experience have proven this packing best suited for the work.

Packed in dust-proof cartons—extra sets can be kept in reserve—always in perfect condition for emergency use.

"SPARE THE ROD"

GARLOCK PACKINGS

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HAMILTON, ONT.

Branch Offices:

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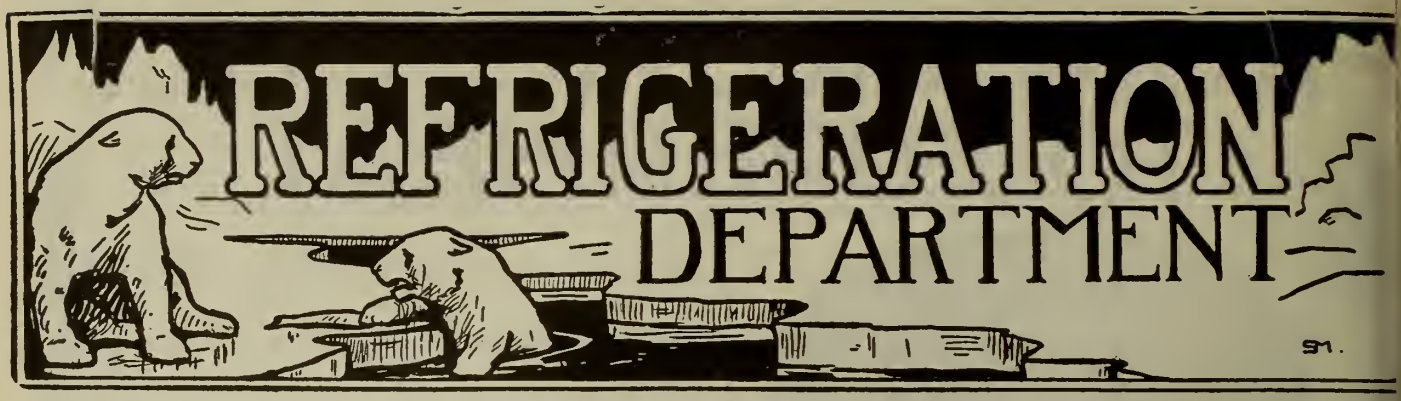

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REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

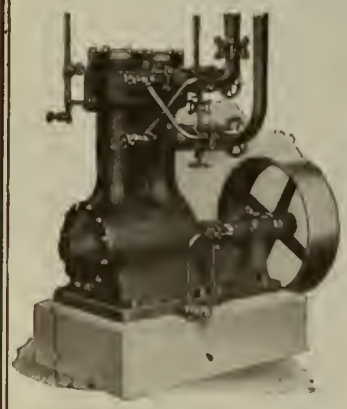
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

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Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

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conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

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Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

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WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

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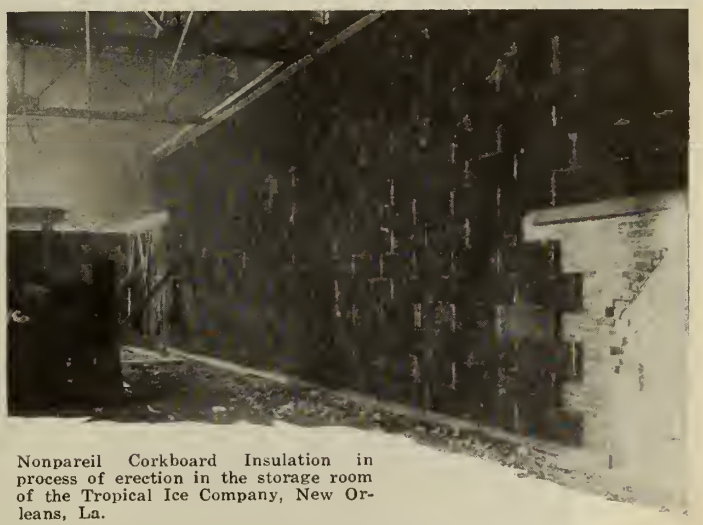
Does an Ice Storage Pay?

IT has been clearly demonstrated that the storage of manufactured ice **does** pay. How well it pays depends largely upon the cost of refrigerating the room. Since there is no heat in the product stored, practically all that refrigeration has to do is to remove the heat that leaks in through walls, floor and ceiling—or, in other words, through the insulation. Hence, the cost of operation and the efficiency of the room are conditioned almost entirely upon the heat retarding value and the durability of the insulating material.

For more than 20 years Nonpareil Corkboard has been repeatedly, continuously and convincingly demonstrating that in insulating value, in structural efficiency, and in permanent resistance to moisture, it is superior to any other type of cold storage insulation. When a sufficient thickness of Nonpareil Corkboard is properly installed, the minimum of refrigeration is required. And the remarkable durability of Nonpareil Corkboard is a guarantee that this efficiency is not temporary, but permanent.



Nonpareil Corkboard Insulation in process of erection in the storage room of the Tropical Ice Company, New Orleans, La.

The Company's Engineers can give you valuable information about the economy and construction of storage rooms for manufactured ice. They will be glad to consult with you without charge or obligation. Write for particulars and ask for a copy of "Nonpareil Corkboard Insulation"—152 pages of insulation facts.

Armstrong Cork & Insulation Company
902 McGill Building, Montreal, Que., Can.
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For Ice Storage Rooms

The York Service Organization

York QUALITY Products and Expert ENGINEERING Advice are brought into close proximity to every user of Ice Making and Refrigerating Machinery by the York Service Organization.

The close, personal touch afforded by this organization in all our dealings with our customers, and the prompt service we are thereby enabled to render, has contributed in no small degree to the Confidence which the Trade places in York QUALITY Products.

Whether you are thinking of installing a new plant, require engineering advice, or need supplies for your Ice Making or Refrigerating Plant, it will pay you to write our nearest Branch.

MECHANICAL QUALITY YORK SERVICE **REFRIGERATION**

The Trade in the Dominion benefits by the ability and experience of this Organization through four regularly established Service Stations.

Canadian Ice Machine Company

TORONTO
Villiers & Munition Sts., Eastern Harbor Terminals

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324 Craig St. West

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YORK MANUFACTURING CO., YORK, PA., U.S.A.

(Ice Making and Refrigerating Machinery exclusively)

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

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"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we thing the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

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Bowser Systems for filtering and serving lubricating oil to bearings are constructed to meet all practicable conditions in connection with engines and other machinery.

A Bowser System provides a stream of cool, clean oil continuously. It reduces the consumption of oils to a minimum by using over and over again. In fact, a change from hand feed lubricating methods to a Bowser System will result in a saving of from 50% to 90% in lubricating expense.

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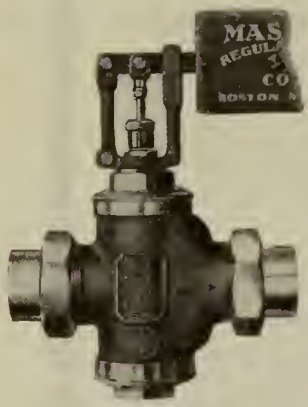
The Mason name on regulating appliances is your best protection against production losses. Mason stands for service, reliability and positive action always. Why then accept a substitute when you can get the original merely by demanding this name?



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Mason Standard Reducing Valve Bronze Body

THE thoroughness with which Mason devices are functioning in even the most critical positions is ample tribute to the way they are built. Every Mason appliance is designed to give better than the ordinary kind of service, and no other device works so accurately, wears so long or accomplishes its purpose so fully.

In addition you get the benefit of Mason Service—a service constituting a staff of expert engineers who aid and advise in the economical installation of Mason Valves or Regulators.

Mason No. 55 Style Pump Pressure Regulators

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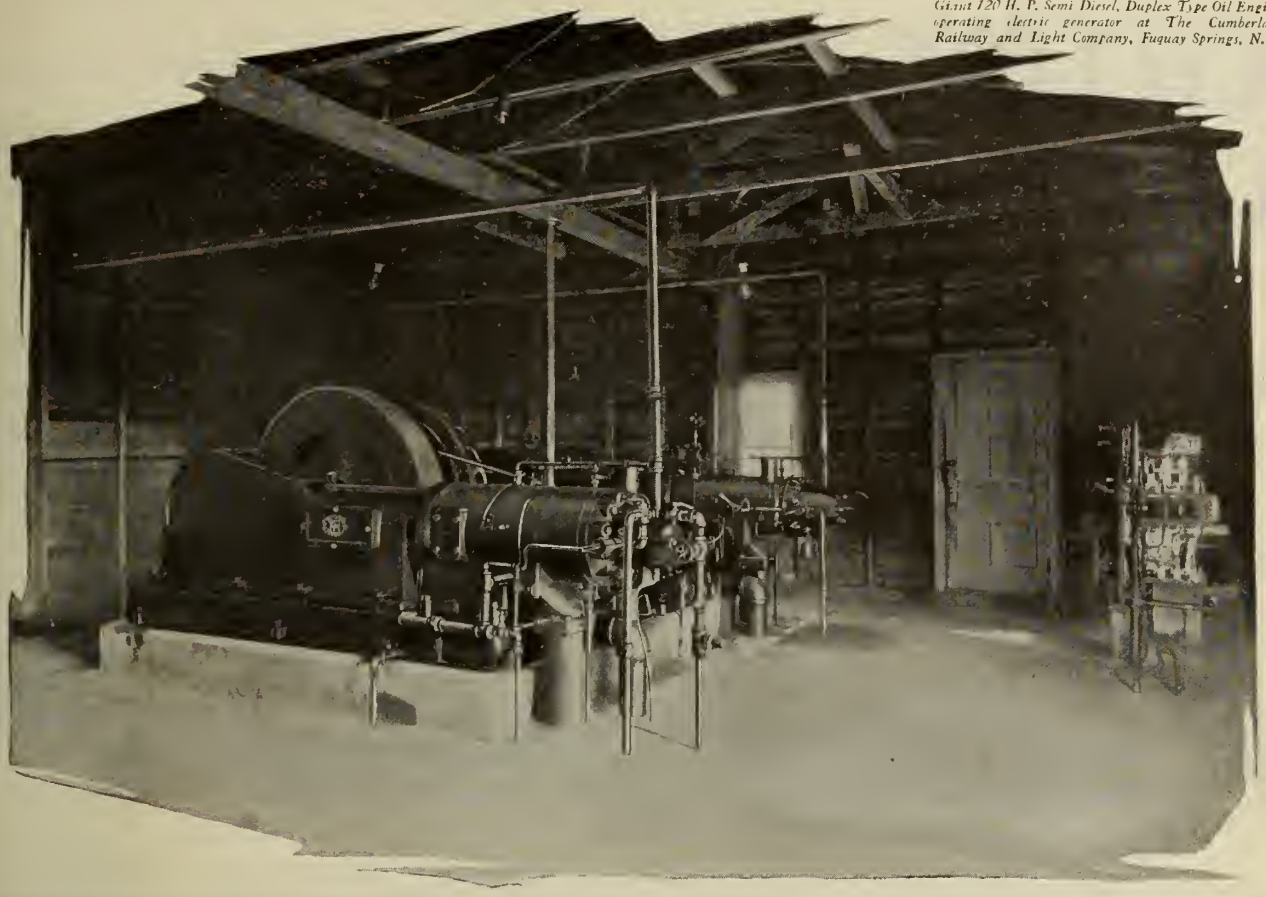

Giant 120 H. P. Semi Diesel, Duplex Type Oil Engine operating electric generator at The Cumberland Railway and Light Company, Fuquay Springs, N. C.

The Hot-Liner ignition system insures quick starting

USERS of Giant Semi-Diesel Oil Engines are spared annoying delays in starting. Quick, positive starting is assured by the *Hot-Liner*—the most perfect ignition system yet developed for oil burning engines. Operation once started is entirely automatic.

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The performance records of thousands of Giant Oil Engines in daily service offer convincing evidence of their superiority in producing *dependable-power-from-low-cost-fuel-oils.*

What are *your* monthly power bills? How much could a Giant Oil Engine reduce them? Expert engineering counsel, extended without obligation, is available to assist you in answering these questions. Address the nearest branch.

Giants are built in single and duplex types, capacities from 12 to 200 H. P. Bulletin 389 contains descriptive details.

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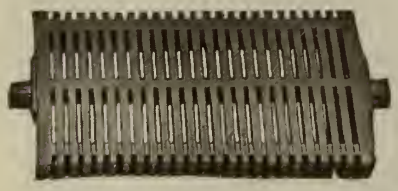
CYCLONE GRATES

THE jarring, shaking movement of Cyclone Grates sifts **all** the ashes through—and **all** the good fuel remains.

The scientific design of Cyclone Grates enables you to satisfactorily burn screening and low-grade fuel—their 60% air space and 90% under-draught means no clinkers —no waste!

Write to-day for full particulars of our thirty days' free trial offer!



The Canadian Steam Boiler Equipment Co., Limited

Sole Makers for Canada

20 McGee Street **Phone G. 3660** **Toronto, Ont.**

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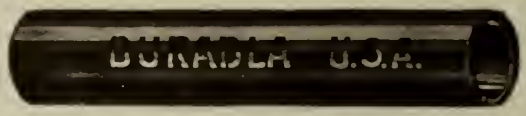
Etched on 

Every Glass

TESTS OF HIGH PRESSURE GAUGE GLASS

Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

Tensile Strength—Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.

Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

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$120.00 Saved in One Day

Coal is deposited direct on pile

Monorail I-Beam Installation

Another company has reported the above savings in unloading and storing coal with their GODFREY CONVEYOR.

They also have written us as follows: "We have on several occasions had three cars on the track in one day with an average of 42 tons to a car, and unloaded them in six hours with one man. We never give demurrage a thought any more, whereas we would formerly average one car in three."

You Can Do the Same

Save time and labor
Release cars promptly
Eliminate costly demurrage
Unload, store, and reclaim.

A request for our Canadian Representatives in your territory to make recommendations and estimates involves no obligation.

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Originators, Patentees and Manufacturers of Conveyors, operating gravity-filled bottom-dump bucket over monorail

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Investigation Leads to Conviction

Just why Sturtevant Steam Turbines have given continued satisfaction with minimum upkeep expense during the twelve years they have been on the market, will be fully understood after each detail described below has been studied carefully. The name

Sturtevant
(TRADE MARK)

on turbines assures economy and dependability in service.

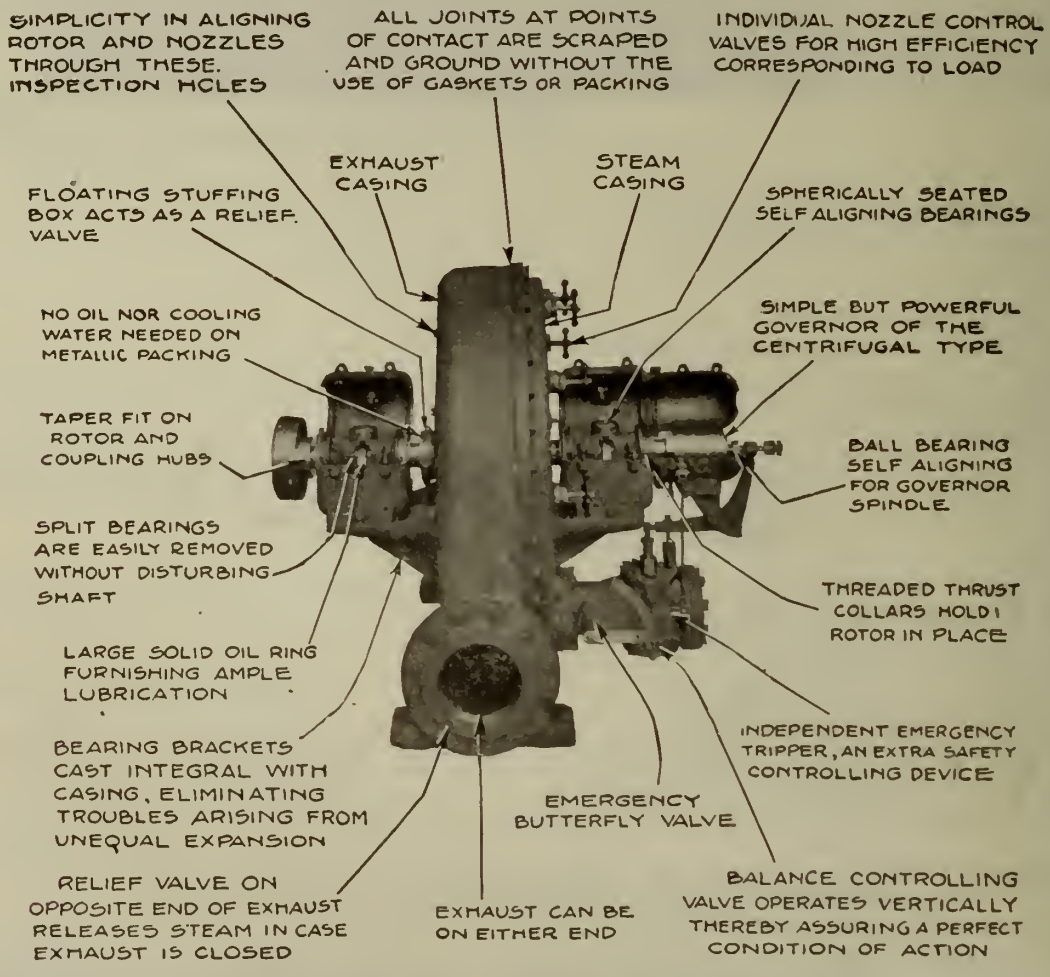
This type of Sturtevant Turbine is especially fitted for driving fans, blowers, generators and pumps, with the minimum steam consumption, attention and repairs.

Only perfect workmanship, and the best obtainable materials are incorporated in their rugged construction.

Economy of operation is assured. Each nozzle is controlled by a hand valve on the outside of the casing and one or more may be separately closed when the turbine is to be operated continuously on a light load. Reversing buckets are cast together in segments, polished smoothly to reduce steam friction. If the speed of the machine gets beyond normal speed the emergency valve instantly and automatically closes.

Made in horsepowers from one to four hundred.

Thousands of satisfied users. Write for our catalogue 256 U with full information concerning the advantages of Sturtevant turbines.


SIMPLICITY IN ALIGNING ROTOR AND NOZZLES THROUGH THESE. INSPECTION HOLES
ALL JOINTS AT POINTS OF CONTACT ARE SCRAPED AND GROUND WITHOUT THE USE OF GASKETS OR PACKING
INDIVIDUAL NOZZLE CONTROL VALVES FOR HIGH EFFICIENCY CORRESPONDING TO LOAD
EXHAUST CASING
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FLOATING STUFFING BOX ACTS AS A RELIEF VALVE
SPHERICALLY SEATED SELF ALIGNING BEARINGS
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TAPER FIT ON ROTOR AND COUPLING HUBS
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INDEPENDENT EMERGENCY TRIPPER, AN EXTRA SAFETY CONTROLLING DEVICE
BEARING BRACKETS CAST INTEGRAL WITH CASING, ELIMINATING TROUBLES ARISING FROM UNEQUAL EXPANSION
EMERGENCY BUTTERFLY VALVE
RELIEF VALVE ON OPPOSITE END OF EXHAUST RELEASES STEAM IN CASE EXHAUST IS CLOSED
EXHAUST CAN BE ON EITHER END
BALANCE CONTROLLING VALVE OPERATES VERTICALLY THEREBY ASSURING A PERFECT CONDITION OF ACTION

B. F. STURTEVANT COMPANY OF CANADA, LTD.

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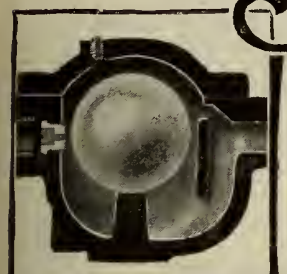
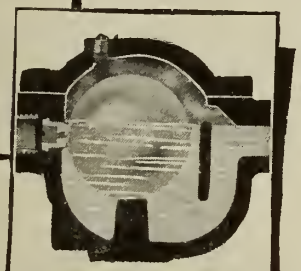
Trapped!

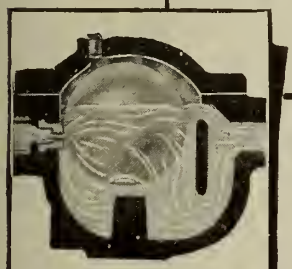
An educational movie showing how steam is trapped and water and air escape



The empty trap —ball resting on the post.

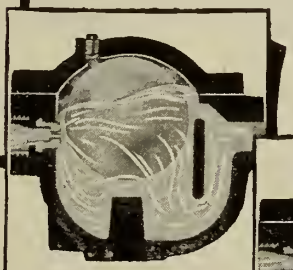


Water, steam and air enter trap.



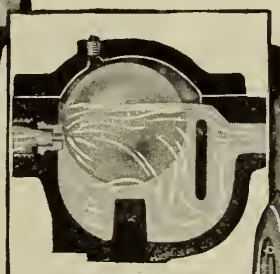
Water floats ball, carries it to outlet bushing and holds it there.

Water level rises, ball rises uncovering discharge orifice in bushing—water flows from trap.



The buoyant force of the water lifts the ball, pressure holds it to the bushing face. The ball actually rolls upwards on the face of the bushing.

Peak load—trap operating full capacity, discharge orifice entirely uncovered. At such periods the ball is swirled around and reseats itself when water level falls.



Water slug has been discharged. Water level lowered and trap operating normally and continuously, discharging water and air.

HERE'S the simplest steam trap made—the Johns-Manville Trap. It operates continuously and faithfully—without any fussy mechanism to get out of adjustment or order.

The unattached floating ball is the only moving part of the trap. Part of its surface acts as the valve, its radius as the lever arm and its weight as the counterweight. The forces that control its movement are the buoyant force of the liquid and the unbalanced pressure on the area of the discharge orifice.

Look at the illustrations which show clearly why the Johns-Manville Steam Trap is the most efficient and dependable trap you can buy.

Thousands of Johns-Manville Steam Traps in satisfactory service tell this same story.

CANADIAN JOHNS-MANVILLE CO., LIMITED

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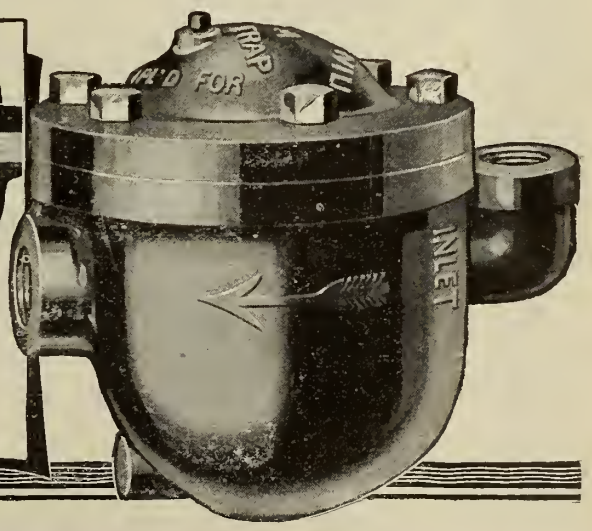

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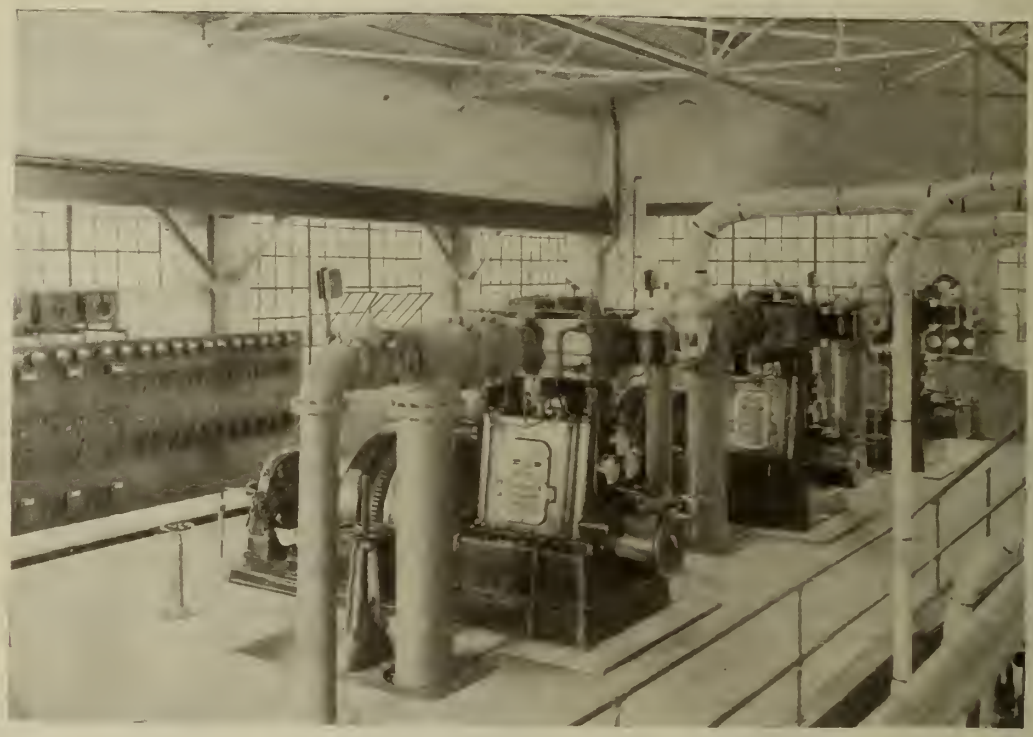

Compound Vertical Forced Lubrication STEAM ENGINES

AMONG other things, limited floor space often demands engines of the vertical type. Illustration shows Compound Vertical Forced Lubrication Steam Engines at the plant of the Log Supply Co., Limited, Berthierville, Quebec.

G. & McC. Co. engines have definitely established themselves in Canadian industry. They are designed to give long and satisfactory service under modern high speed conditions, to require the least possible attention, give perfect regulation, and have all parts simple and of easy access.

Our catalogue explains fully. Write for a copy.

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POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The First True Diesel Made In Canada

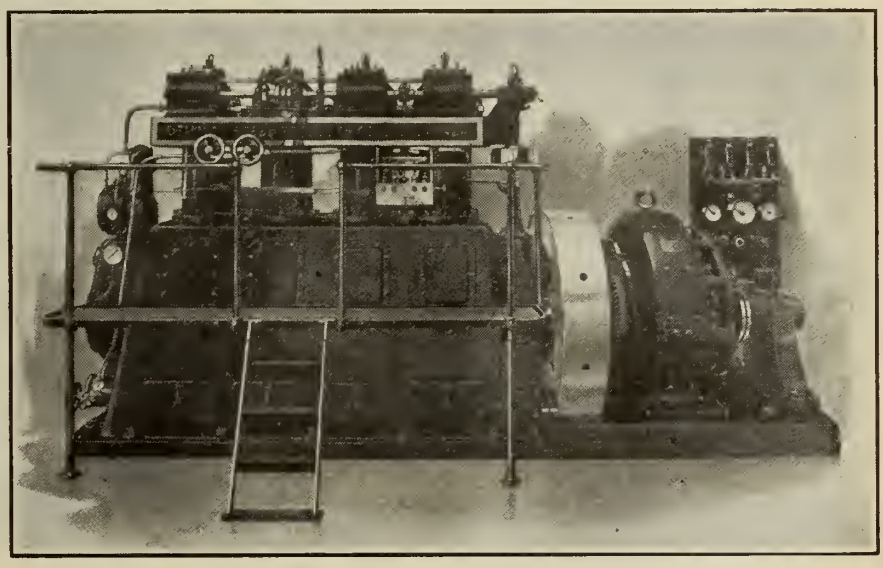
The History of the Diesel Engine—Two-Cycle, Four-Cycle, Solid Injection and Atomised Injection—General Description of the D. S. P. 100 B. H. P. 4-Cylinder Diesel

THOSE people who were interested in the exhibits shown in the Machinery Hall at the Toronto Exposition last year doubtless all stopped for a more or less interested look at a new kind of engine. This was the 125 h.p. Diesel exhibited by the Dominion Steel Products Co. of Brantford, and the first of its kind to be built in Canada. It is of the full or true Diesel type, as distinguished from the hot bulb or other surface ignition engines. This type of engine will doubtless have a great part in the developing of some of the outlying parts of our country, and every engineer should understand its principles and operating features.

The History of the Diesel

The Diesel engine should really be known as the Ackroyd Priestman engine, as the cycle it works on was first mooted by these two engineers in England, some years before Dr. Diesel took up the study of this principle. However, Dr. Diesel is usually conceded to be the man who first actually demonstrated its possibilities, and the basic patents were taken out by him in 1892. He built his first engine in 1893, and this was driven by a belt and did not do any work. What it did do, however, was to prove that oil could be ignited by the heat of compression of air, which is the main feature of the true Diesel engine. In the experimental engine, Dr. Diesel obtained a pressure of 1,350 pounds per square inch, and incidentally when the fuel was injected, the explosion that followed wrecked the engine. It almost resulted in the death of the inventor, but he rose from the ruins triumphant, for, even if the engine was demolished, the principle was established that the fuel could be ignited by means of the heat of compression.

Another engine was built, this time the compression being kept down to 500 pounds per square inch, and on this occasion the full cycle was obtained. Later another engine was built, with the cylinder water cooled, in 1896. Dr. Diesel sold his patents in 1897 for the sum of $1,500,000, so unlike many inventors, he actually realized the reward of his endeavor. His life ended in a tragic manner, he being lost at sea while journeying from Antwerp to Harwich in the year 1913.



D.S.P. H.C. OIL ENGINE. FOR CENTRAL STATION SERVICE.

The Cycle of Operation

The Diesel engine is built in two principle types, the two and four stroke cycle. These types are divided again into other modified classifications. In general, the two stroke cycle gets an ignition at each revolution, and the four stroke cycle receives an impulse every second revolution. In the two cycle type, on the inward or upward stroke of the piston, the products of combustion are discharged, and a fresh charge of air drawn in and compressed. At the top of the stroke the fuel is injected, and the down stroke is the working stroke. In this type the scavenging, or getting rid of the exhaust gases, is a difficult problem, and various means are employed to effect it. The simplest, and most generally used, is crank case compression. The piston descending on the downward stroke, compresses the air in the crank case to five or ten pounds, and this air sweeps through ports on one side of the cylinder when uncovered by the piston, and drives the gases out through a set of ports on the opposite side of the cylinder. Enough air is received on top of the piston to give the necessary compression. In other types the scavenging is done by a separate pump. Then there is the opposed piston type, in which the compression takes place between two pistons in one cylinder, and the working stroke is obtained by one piston ascending and the other descending. These work on three cranks, two of them being at 180 degrees to the other. The top piston is supplied with a crosshead, from which two connecting rods are connected to the two cranks at the outside, while the bottom piston is attached to the centre crank. When explosion or ignition takes place, the top piston pulls the two outer cranks up, while the centre crank is pushed down by the bottom piston. This type is known as the Junker, pronounced Yunker. Very often the scavenging in this type is done by a separate air compressor, instead of using the crank case compression.

The four cycle type is divided into solid injection and air spray injection.

In the solid injection type the fuel is injected by a fuel pump working at a pressure of 6,000 to 8,000 lbs., directly into the combustion chamber. In the air spray type, which is the one we are about to describe, the fuel is injected into a chamber containing compressed air at a pressure of about 1,000 lbs. per sq. inch, and shot into the combustion chamber as a finely atomized mixture of air and oil.

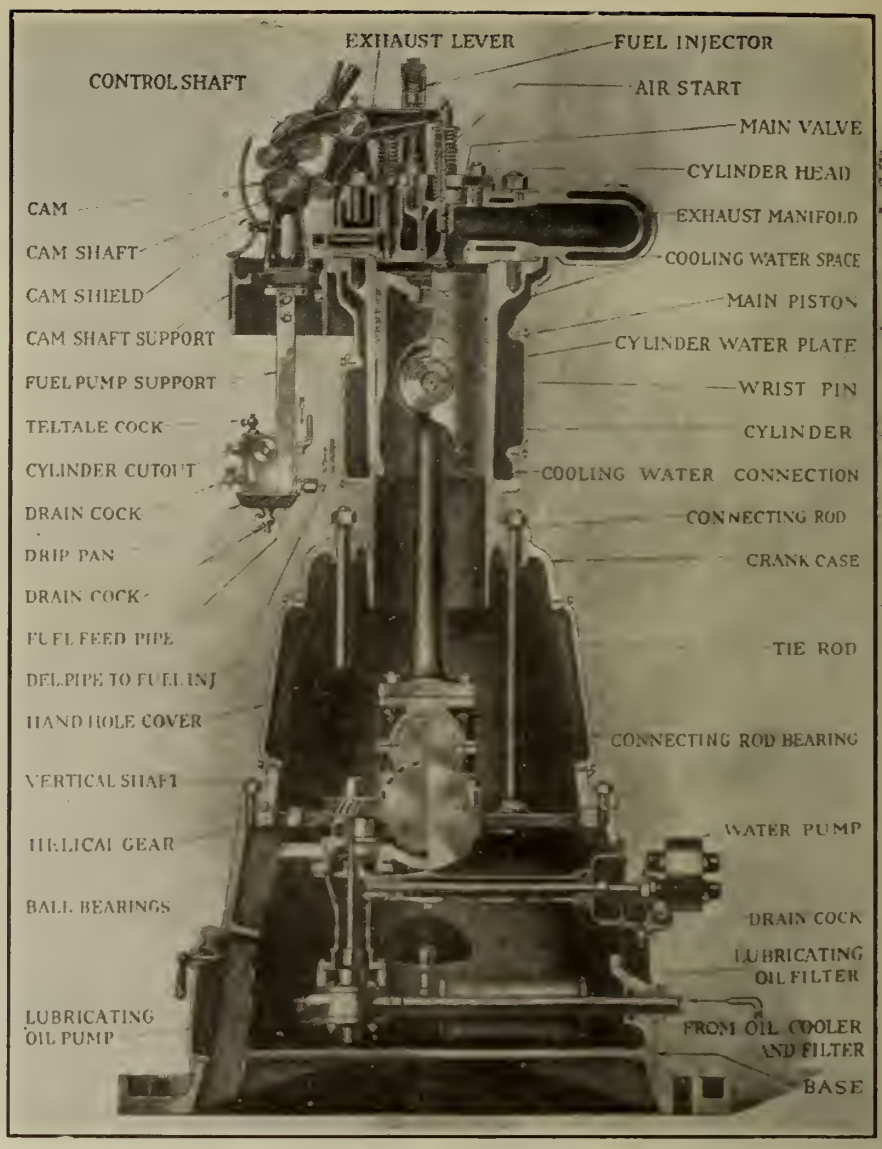
The two types have their different adherents, the solid injection school claiming that their method does away with the necessity of an air compressor steadily running, while the air spray school claim better combustion, which amply makes up for any supposed disadvantage from the use of a high-pressure air compressor.

The Four Cycle Type

In the four cycle type the first downward stroke, or outward stroke perhaps is a better way to put it, draws in a charge of pure air from the atmosphere, not the crank case. On the inward stroke this air is compressed to the required pressure, about 550 lbs., and at the top of the stroke the finely atomized fuel is injected by the air pressure from the air compressor delivery chamber. Ignition takes place at constant pressure, and the third stroke is the working stroke. On the fourth stroke the exhaust gases are discharged through a special exhaust valve and the cylinder is ready for the cycle to be repeated. The cycle may be described as suction, compression, expansion, and exhaust.

The D.S.P. Engine

The illustration herewith gives a good idea of the outside appearance of the engine, directly connected to a generator, for power and lighting service. This is exactly as the engine appears in the shop where it is now engaged in running a number of machines and overhead cranes. The engine is four-cylinder, four cycle, spray injection. On the end opposite the flywheel and generator is the air compressor for injecting the fuel, and supplying the air bottles, which are used for starting purposes. On the front can be seen the fuel pump. Both of these pieces of apparatus will be described fully later on. The engine operates on crude oil, with a specific gravity of about .865, or even higher, but with this specific gravity the oil will flow without heating in to the fuel pump. The efficiency of the engine is high, as it will deliver practically 30 per cent. of the fuel energy at the pulley as useful work. This is, of course, much bigger than with any type of steam prime mover, and is attained in the Diesel engine because the fuel combustion takes place in the same chamber that the work is done in. With the steam engine, the combustion takes place in a furnace, the heat is conveyed through the plates of the boiler into the water, and then carried

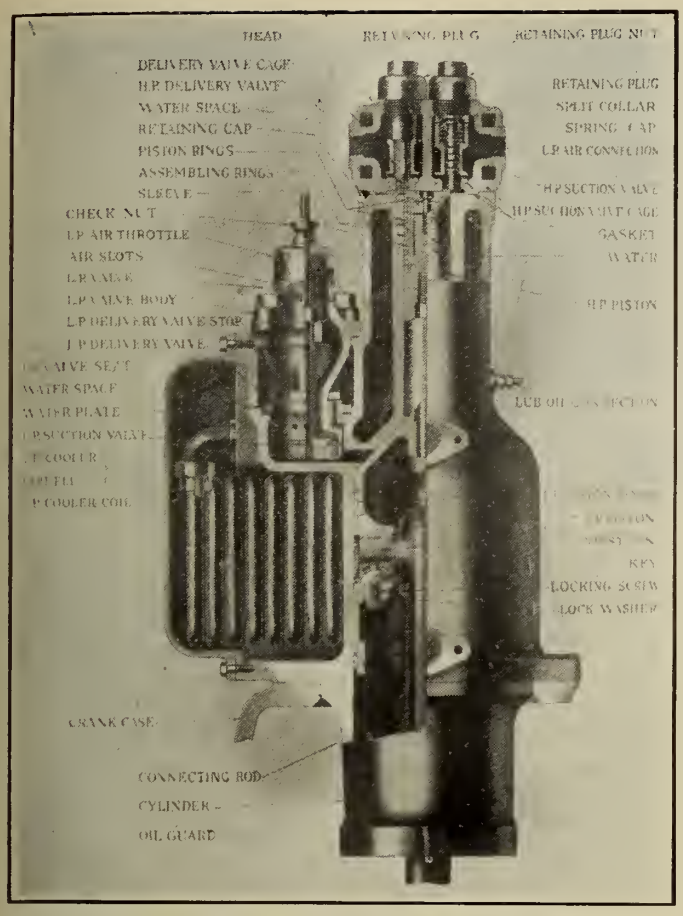


CROSS SECTION THROUGH CYLINDER.

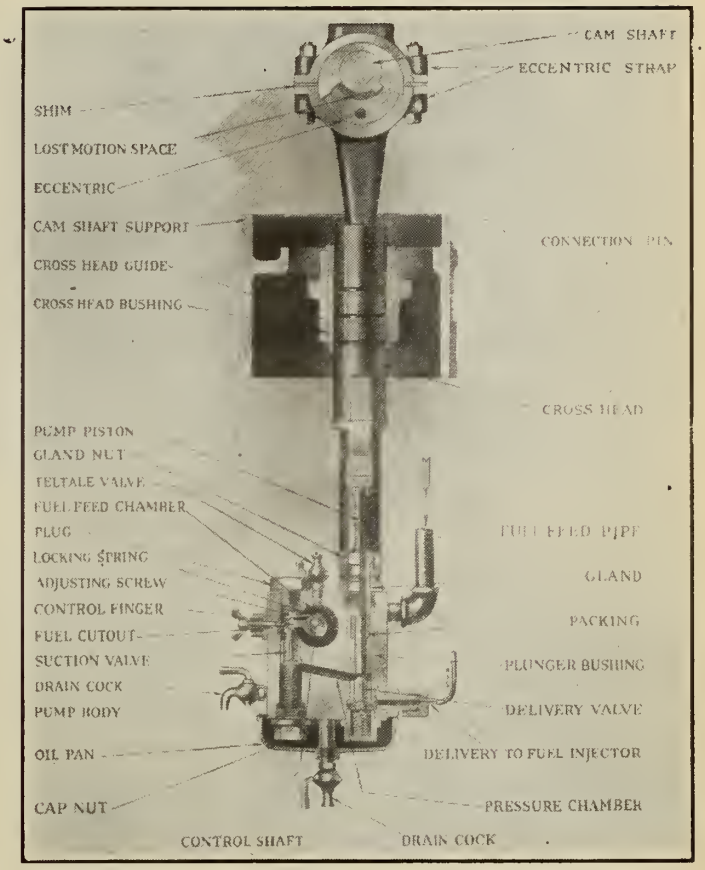
by the steam through piping into a cylinder or turbine casing, with many losses on the way due to radiation and friction.

In the engine we are dealing with compactness of design has been studied to good effect. It is necessary, of course, in an engine of this type to make provision for starting up. The method of starting is to admit compressed air to the cylinder to obtain the initial revolutions and compression. In order to do this it is necesary to have always a reserve of compresed air, and for this purpose bottles or flasks are provided, much like ammonia or oxygen cylinders. In most cases these are mounted on a wall convenient to the engine, but in the D.S.P. engine, provision has been made for carrying these bottles in the bedplate of the engine. This arrangement makes the engine absolutely self-contained, and ready to start the minute it is dropped down and secured to the foundation, and connection made to the fuel oil supply. The air is supplied to the bottles by the two stage air compressor situated on the end of the engine, and after the engine is started up this compressor supplies the air continually to the air injection valve for atomising the fuel. Such surplus air as may be delivered is diverted to the bottles.

The fuel pump is worked from a small crosshead, which is driven from a special eccentric mounted on the cam-shaft, which operates the valves. There are four plungers on this pump, one for each cylinder. The amount of fuel injected at each stroke is varied by a governor, which operates by holding the suction valve of the fuel pump open for a longer or shorter time, thus controlling the amount of fuel delivered per stroke. Holding the suction valve open, of course, is the same thing as shutting off the supply, and the speed of the engine is regulated very closely by this means. Each cylinder has the necessary valves for air start, fuel injection, and exhaust, and in addition to these, the two centre cylinders are supplied with air starting valves. These valves can be put on each cylinder if required, and the cylinder head is machined to receive them, but in practice it is only found necessary to use the two mentioned. These valves are all operated from a cam-shaft, driven by gearing from the main shaft. The



SECTION THROUGH AIR COMPRESSOR.



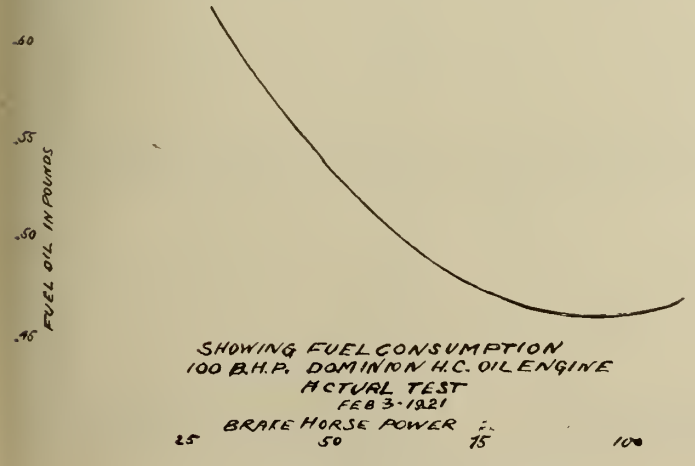
SECTION THROUGH FUEL PUMP.

cams operate levers, which open and shut the valves at the precise period of the stroke necessary to accomplish the various functions. The action of these cams is, of course, exactly the same as on a gas engine or a gasoline engine, with which most of us are familiar these days.

Starting the Engine

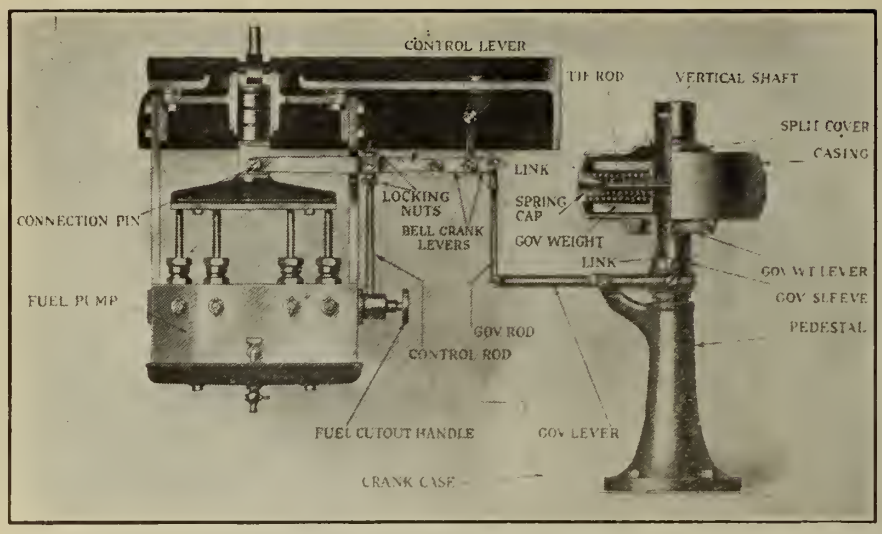
In starting the engine the following is about the method of procedure. The reserve air bottles will have been left when the engine shut down with a pressure of about 950 to 1,000 pounds, and will have, perhaps, dropped owing to the cooling of the air to about 800 lbs. or perhaps a little less. The operator first of all raises the relief valves of the cylinders by means of a special lever, which action releases the compression in the cylinders, and allows him to bar the engine round to the air start position. This position is, of course, that in which the air start valves on the two inside cylinders will be open for the admission of air. He then closes the relief valves again, and opens the valve from the air bottle. The engine immediately turns over, and the operator, who has previously seen that the fuel tank is full and ready for the day's work, opens the fuel control valve to give fuel to the pump, and closes off the air start valves by means of a control lever, which puts the air start lever into neutral position. This particular engine usually picks up after a couple of revolutions from dead cold. The operator comes in about ten minutes before starting time, looks at his fuel tank, gives a general look around the engine, and starts her up about five minutes to the hour, and is all ready with the current at the switchboard when the shop is ready to start.

Once started, the engine requires practically no attention. The air compressor draws in the air from the atmosphere, passes it over the element containing the air coming from the low pressure stage to the high pressure stage, thus cooling the latter, passes the air through its two stages, the final delivery pressure being from 900 to 1,100 lbs., according to the load being carried. This air is delivered to a chamber on top of the cylinder, and



FUEL OIL PER BRAKE HORSE POWER.

FUEL OIL PER KILOWATT.



THE GOVERNOR AND CONNECTIONS.

POINTS ON CONSTANT PRESSURE DIESEL ENGINE.

It can use high compression pressures as it does not compress a mixture.

The mixture is very lean and burns slowly and loss in cooling water is less.

Four gallons of cooling water per B.H.P. ample.

Perfect combustion due to complete atomizing and slow burning.

Oil of high flash point, thus cheap oil can be used.

Typical test data:—

Compression pressure per square inch, 510 lbs.

Mechanical efficiency, 82.5 lbs.

Fuel consumption per B.H.P., .45 lbs.

Cooling water Temp.—in, 46 deg. F.

Cooling water Temp.—out, 103 deg. F.

Exhaust gases, temperature, 600 deg. F.

Heat value of fuel, B.T.U., 19,000.

Specific gravity of fuel, B.T.U., 86.5.

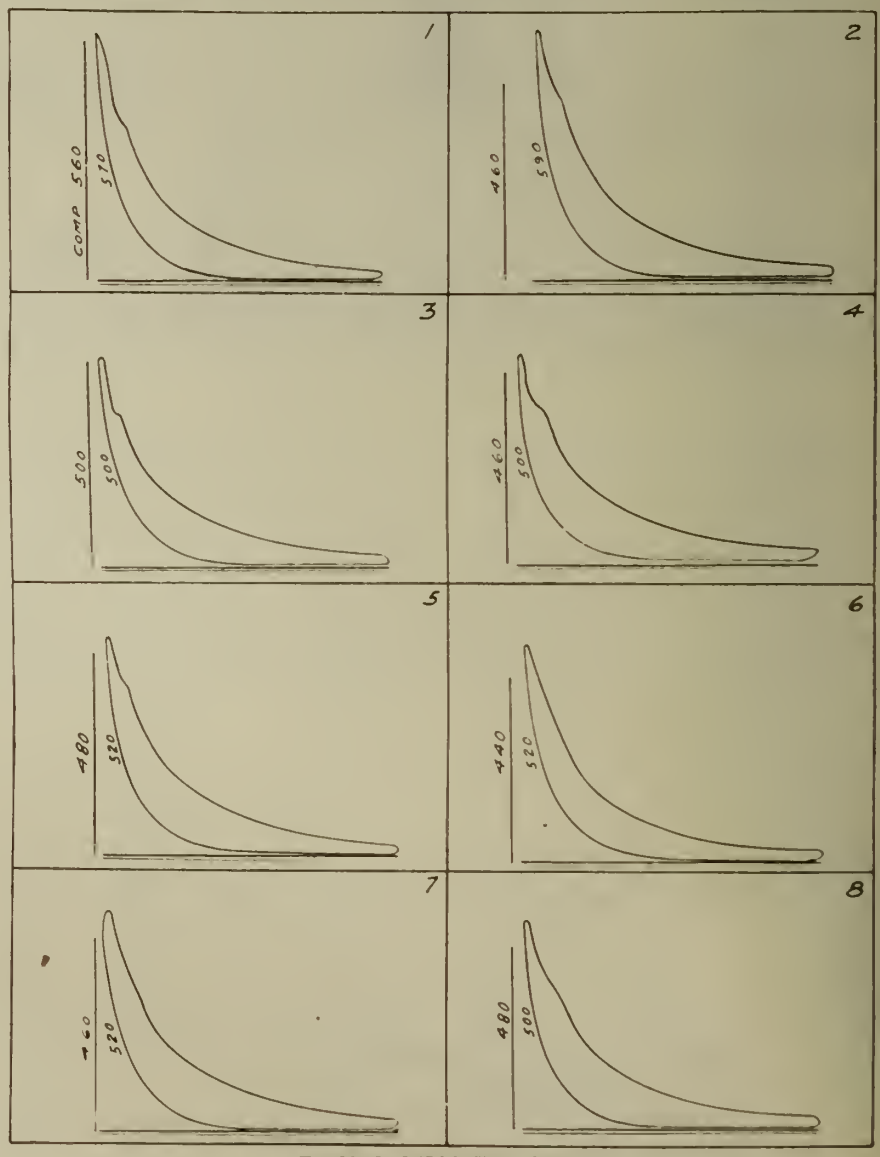
at the proper moment the fuel from the fuel pump is injected into this chamber and the valve from the chamber into the cylinder is opened, and the finely atomised spray of oil fuel injected. Ignition takes place without shock and combustion at practically constant pressure ensues, the gases expanding and driving out the piston. At a point just before the bottom of the working stroke is reached, the exhaust valve is opened, and held open throughout the return stroke discharging the exhaust gases. At about the top of the stroke, the cam closes the exhaust valve, and opens the air suction valve, and the cylinder is filled full of pure air. The valves are then all closed, while compression takes place on the fourth stroke, and at the end of this stroke ignition again occurs.

A pump situated in the base of the engine supplies oil under a pressure of ten to fifteen pounds to the crank pin, and through the connecting rod to the wrist pin, while special lubrication is supplied to the piston. The air compressor is lubricated by the oily spray generated in the crank pit by the passing of the cranks through the oil bath, and this is all the lubrication employed for the air compressor.

The accompanying illustration shows the typical indicator cards obtained from this engine, while the section cuts explain very clearly the working parts. Fuel consumption is shown by the curves illustrated here.

A representative of Power House had the opportunity recently of seeing this engine performing its daily task, and was impressed with its splendid performance under somewhat difficult circumstances. This engine was built with an ordinary sized flywheel, to drive a generator on fairly constant load. The work it is doing now is under very considerable variation of load, from no load to a 50 per cent. momentary overload occurring frequently. The speed regulation under these conditions was excellent, and standing at the exhaust pipe, the only indication of anything unusual was a puff of blue smoke. At ordinary load the exhaust was practically invisible, showing excellent conditions.

The Dominion Steel Products are to be congratulated on being the pioneers in Canada of this type of prime mover, and its development will be watched with interest by the engineering profession in general. Mr. Brown, the designer of the engine, gave a highly interesting lecture on the engine before the Canadian Association of Stationary Engineers recently, which was well attended, and discussed with interest by those present.



TYPICAL INDICATOR CARDS.

Breaking Cylinders Through Excessive Water

Some of the Causes of Damage to Cylinders Through Slugs of Water Being Drawn in by the Piston—How to Prevent Those Occurrences

OF all the causes of accidental injury to steam engines the presence of an extraordinary amount of water in the cylinders is one of the most prevalent. After the exhaust valve closes, this water, forced by the piston into the space remaining in the cylinder, has no ready means of escape. If the clearance space is quite large and the engine is running very slowly, there is a possibility of no damage resulting. If the water is sufficient to more than fill the clearance space, however, an irresistible pressure will be produced and something must give way to relieve it, says the Locomotive.

All engines are, or should be, provided with cylinder drains or drips, one at the throttle valve and one in each end of the cylinder, for the purpose of removing the water of condensation when starting. Ordinarily these drips are closed by means of a plain globe or angle valve, though in many cases the cylinder drips are fitted with spring loaded relief valves which may be opened also by hand. The principal safeguard that such spring loaded valves may afford is in the relieving of unduly high steam pressure. Contrary to a somewhat prevalent belief, valves of this type are of little or no use for draining the cylinder should water in any appreciable amount enter through either the steam or exhaust pipe while the engine is running. Water, at rest or when set in motion, has considerable inertia. When the piston drives a volume of water before it in its stroke, the water is flowing in lines parallel to the axis of the cylinder and a considerable force is required to turn it from this direction of flow. To expect it to make a sudden, right-angled turn and to converge all its lines of flow into a relatively small drain pipe is not reasonable. Even a relief in the center of the cylinder head would be wholly inadequate in a case of this kind.

Probably the most frequent result of excessive water in the engine cylinder is that the cylinder head is blown off. The head itself may be broken, the thread on the cylinder head studs may strip, or the studs or bolts themselves may pull apart, and not unfrequently the wreck may involve failure of all of these parts. Sometimes the cylinder itself may be cracked or badly broken and there are numerous instances of the excessive pressure having driven the piston on or off the piston rod. The cylinder and piston construction may be strong enough to withstand the shock and to transmit the force developed to other parts of the engine so that a piston rod may be broken or bent, a crosshead may fail, the connecting rod may be damaged, or the force may be transmitted still further to the crank and shaft of the engine so that these parts may suffer serious injury. Sometimes the shock is so great that the engine is a complete wreck. Water in an engine cylinder is, in fact, so serious a matter that every precaution should be taken to remove the possibility of its presence.

When the boiler feed water contains foreign substances in sufficient amount to cause excessive foaming and priming, there is great danger of water being carried over to the engines in amounts sufficiently large to cause damage. If the engine is some distance from the boiler and the steam pipe is exposed, there is also the possibility of excessive condensation taking place so that the engine may sometime receive a "dose" of water sufficiently large to wreck it. It is best, under any condition, to provide a separator in the steam line, which should be connected close to the engine throttle, not only for the purpose of removing excessive amounts of water, but also for the extraction of small amounts of moisture in the steam. It is always in the interest of economy to supply the engine with as dry steam as possbile.

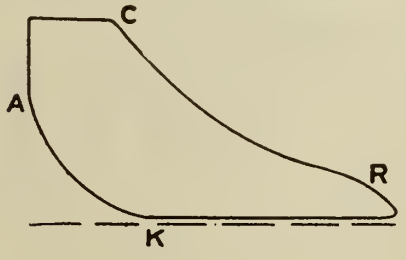


FIG. 1.

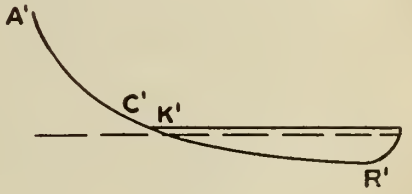


FIG. 2.

The function of the steam separator is to separate the liquid from the vapor in the steam pipe, but after this has been accomplished some means must be provided to drain the separator of the water. To do this a drain pipe is provided to conduct the water to a steam trap which will discharge the water, but not the steam, to the atmosphere. It is best to have as short and as direct a drain pipe as possible from the separator to the trap and numerous fittings and valves are to be avoided. If a valve is installed in the drain between the separator and the trap, it should be locked or sealed open. Steam traps, at times, will become inoperative from some cause and if such a condition prevails the separator, of course, is deprived of a drain so that it will accumulate water and will thereby become valueless and even dangerous. The steam trap, therefore, should be carefully watched and inspected to make sure that it is, at all times, in perfect working order.

There have been many cases of engine wreckage from water taken into the cylinder from the exhaust piping. When a cold engine is started the throttle valve is opened, of course, only a slight amount and there is the possibility of a vacuum forming by rapid condensation of the steam in the engine cylinder so that if, by chance, any water be present in the exhaust line there is great likelihood of its being drawn into the engine cylinder. Then, when the engine turns over, the water is trapped in the cylinder and is the cause of damage. To guard against the possibility of wreckage from the cause just mentioned precautions should be taken to prevent the accumulation of water in the exhaust pipe. From the standpoint of ease of removal of the water the best way would be to have the exhaust pipe so installed that it will act as its own drain, the water running by gravity to the open end of the pipe. In the great majority of cases, however, the exhaust pipe, before reaching an open end, rises above the engine cylinder so that a pocket is formed in which water may very readily accumulate. Such lines should be equipped with ample size drain pipes located at the lowest points of the exhaust pipe and the installation of these lines should be carefully studied to see that they are drains in fact and not additional pockets in the system.

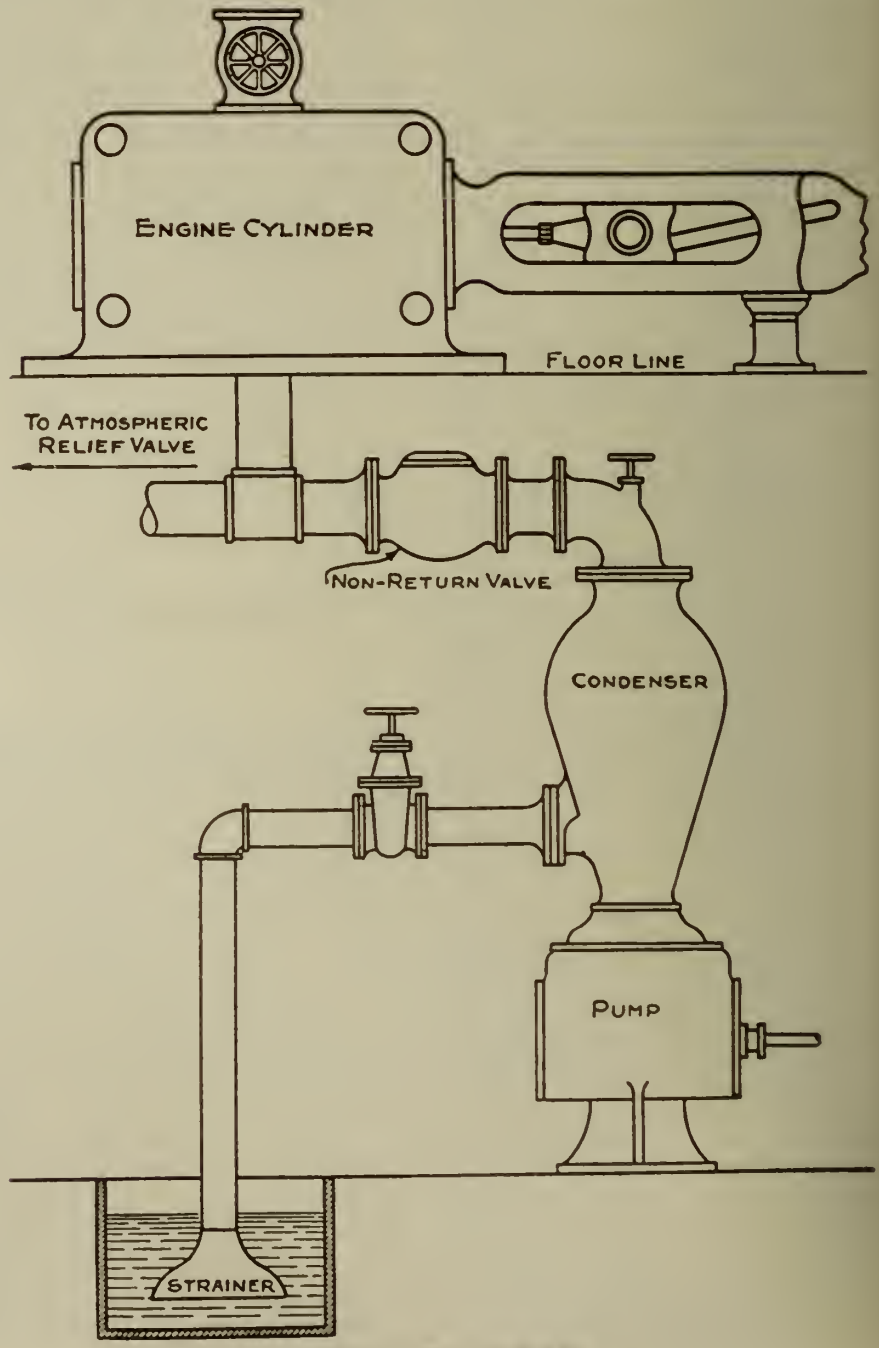
When a cold engine is to be put into operation it is necessary that certain precautions be observed before it is set in motion. If the steam be admitted to the engine too rapidly, severe expansion stresses will be set up in the engine parts which might lead to cracking of the cylinders. Furthermore, when steam is first admitted to a cold engine, and until the machine becomes warmed, rapid condensation will take place with consequent formation of a sufficient amount of water to give rise, should the engine turn over before this condensa-

tion ceases or the water is removed, to a greater or less degree of shock. It is therefore quite essential that any steam engine, before it is started, be brought up to temperature slowly and gradually. The length of time required for this is naturally a factor depending entirely on the size of the engine.

With Corliss engines, or with any other type in which the valve gear can be operated by hand, the cylinder is readily warmed by "cracking" the throttle a little and turning, alternately, the steam valves at the head and at the crank end to the open position. The valves of some engines cannot be operated independently by hand and with these it is necessary to bar the engine over from time to time during the process of warming so that both ends of the cylinder may be heated at as nearly a uniform rate as is possible. It is hardly necessary to call attention to the necessity of closing the throttle before attempting to turn the engine over. These methods of warming the engine cylinder preparatory to starting are, of course, the necessary steps for a simple engine or the high pressure cylinder of a multiple expansion engine. In the case of a compound engine it is well to warm the receiver and low pressure cylinder by means of the high pressure steam bypass to these parts, when such bypass exists, or by turning the engine over several times by hand to permit the steam from the high pressure cylinder to flow on through the engine. By thus thoroughly warming the engine before starting the danger of producing a vacuum in the engine cylinder and thereby drawing any water from the exhaust pipe into the cylinder will be greatly reduced.

When shutting down an engine there is a condition produced which makes the entrance of water into the engine cylinder from the exhaust pipe, should it be present there at such time in sufficient quantity, an almost absolute certainty. In order to understand how this condition is produced, reference will be had to some indicator diagrams. Fig. 1 shows a typical card or diagram for an average engine under load. The steam valve opens for the admission of steam at A and closes or cuts-off at C. The exhaust valve opens or releases at R and closes for compression of the steam remaining in the cylinder at K. Suppose now that the throttle of the engine is closed to stop the engine. On the next revolution, when the piston arrives at the point in its stroke indicated by K, there still will be some steam left in the cylinder and this steam will be compressed along the line K′ A′ of Fig. 2. When the piston starts in the opposite direction this steam will re-expand. At the point A′ the steam valve opens and the indicator diagram is therefore dealing with a greater volume of steam (the volume in the cylinder plus the volume in the steam chest made available by the opening of the admission valve), so that it is difficult to say just what line this re-expansion will follow. However, since the volume is increasing by the forward motion of the piston and since the steam is condensing somewhat, it is certain that the pressure will fall and it will be fairly accurate for the purpose of this discussion to say that it follows back along the line A′ K′. After the piston reaches the point in its stroke where the steam valve closes, or about at C′, the steam in the cylinder will continue to expand so that the pressure will drop considerably below atmospheric. We thus have a rather low cylinder pressure when the piston reaches the point where the exhaust valve opens. If a considerable quantity of water has accumulated in the exhaust pipe from any such cause as, for instance, the premature stopping of the pump of a jet condenser, this water may readily be drawn up with a rush into the engine cylinder. This rising of water into the cylinder in an attempt to equalize the cylinder pressure with that of the atmosphere results in the upward curve of the indicator card at the point R′.

When the engine makes the return stroke with the exhaust valve open, the water is carried ahead of the piston into the end of the cylinder. Some of it, of course, will return to the exhaust pipe, but some of it is sure to remain in the cylinder. When the water was drawn into the cylinder there were forces acting in a very positive direction to move it. After it enters the cylinder these forces are not so definite in their direction and the inevitable result will be that considerable water will be trapped in the cylinder after the exhaust-



TYPICAL JET CONDENSER.

valve closes. With the engine still turning over at close to its normal speed and with no escape for the water, the result is obvious.

With condenser operation, it is rather common practice to install an automatic device on the condenser for the purpose of "breaking" the vacuum should the condensing water rise into the exhaust pipe. These vacuum breakers consist, quite frequently, of a float inside the condenser which, when the water rises, opens a valve to admit air to the condenser above the water level so that the further influx of injection water is prevented. This principle of breaking the vacuum is entirely correct but accidents have occurred from the float becoming water logged or from sticking of the valve. If the air is not admitted in sufficient quantity to break the vacuum before the water reaches the level where the air is admitted, the danger is accentuated, for if the water passes the point of air admission the air, when it does enter, will mix with the rising column of water, which will thereby have its specific volume greatly decreased, and it will be possible for the mixture to rise to a higher level than could the liquid alone. In order to avoid the condition just mentioned, it is well to admit the air as close as possible to the engine itself and to use a vacuum breaker that is reasonably positive in its action.

A condition that is sometimes encountered and one that is extremely dangerous is that in which the injection water to the condenser is supplied under a pressure head. With this condition it is possible for the water to flow into the engine cylinder while the engine is at rest so that the machine may be wrecked upon starting up. The water should always be drawn up to the condenser by the vacuum or else the head under which it flows to the condenser should be so small that, with the vacuum removed, the water would not rise to a point dangerously near the engine.

There may be cases in which the water is supplied the condenser from a pond, the level of which at the time of observation or inspection may not be dangerous but which may at times be subject to a large fluctuation from causes such as a heavy rainfall or rising tides and an unsafe condition may thereby be produced.

A very good preventive against the entry of water from the exhaust side of the engine is some form of non-return valve which will close when the water flows toward the cylinder. Such an installation is illustrated. It is always best, of course, to have an atmospheric relief valve in the exhaust line to prevent excessive pressures building up in the low pressure cylinder of a multiple expansion engine and also, of course, to prevent immediate shut-down should the condenser equipment cease to operate. The connection for this relief valve should be between the engine and the non-return valve as indicated in the illustration.

Not only jet but also surface condensers may give trouble if the latter type is so connected that the steam enters the condenser shell at the bottom. This method of piping is sometimes used when there is no basement under the engine and the condenser is placed on a level with the engine cylinder. If the condensate pump stops accidentally, the exhaust pipe will accumulate water from the condensing steam and at the time that the engine is being shut down this water may return to the cylinder to cause damage as explained in the foregoing.

Still another source from which water may enter an engine cylinder is the receiver on a compound engine. Engines of this type are sometimes constructed with a valve gear giving a fixed cut-off to the low-pressure cylinder and are governed by a variable cut-off in the high-pressure cylinder. With a very early cut-off in the high-pressure cylinder the low-pressure cylinder acts as a pump, drawing the steam from the receiver, and this action may continue to the point where the pressure in the receiver will be lower than atmospheric. This is particularly true of an engine operating condensing. The receivers of compound engines are, of course, or at least should be, fitted with drain traps, but as these are sometimes operative only when there is a pressure in the receiver greater than atmospheric the condition outlined above will cause such a trap to cease its functioning. Inasmuch as continued operation under these conditions must result in the accumulation of condensation in the receiver, it is not long before the low pressure cylinder receives a harmful "dose" of water. Of course, the proper apparatus to use for the draining of engine receivers is a special form of trap which will operate under vacuum or pressure so that some means of removing the water is provided under all conditions.

From what has been said above it is evident that there are a number of ways and reasons for the entry of water into an engine cylinder. All of these hazards may be mitigated by the use of the proper apparatus but it must never be forgotten that such safeguards as are installed must be subjected to the most rigid inspection as to the construction and method of installation and that careful watching is needed at all times to obtain dependable service.

The Westinghouse Electric and Mfg. Co., East Pittsburg, has announced a wage adjustment, effective March 1, which cuts the present pay of workmen approximately 15 per cent. The announcement, made by H. P. Davis, vice-president in charge of operations, states that the cut is due to competitive market conditions, the decline in prices and the decrease in volume of business.

GRAPHITE AS A LUBRICANT

All criticisms of graphite can be traced directly to its impurities. The impurities in lubricating graphite my be divided into two classes: those that have a positive abrasive effect and those that act neither as abrasives nor lubricants. Artificial graphite may be made very high in carbon, but since it is a by-product of the electric furnace process of making silicon carbide, it is likely to contain traces of this, which is very objectionable, as silicon carbide is one of the most abrasive substances known. In the natural graphites the objectionable impurity most commonly found is silica, or common sand. So says Brass World, which continues as follows:

The harmfulness of the impurities depends also on the size of the particles. If the size of the abrasive particles in a graphite is greater than the average thickness of oil film, their abrasive effect will be greatest in a bearing running under uniform pressure. On the other hand, in a reciprocating bearing under high duty, where the oil film is alternately broken and restored, all the different sizes or particles of the abrasive material may come into play, and it is in the latter class of bearing that pure graphite is most essential and that abrasive impurities are most harmful.

Among the many impurities in the natural graphite we find some that are not, by nature, abrasive, but are undesirable and injurious to bearings. To illustrate, let us take the particle of a so-called flake graphite, where we have alternating layers of mica and graphite held together in a manner capable of sustaining considerable compression. Let us imagine stoking an engine at night with a layer of these laminated particles between a heavy crankshaft and a babbitt or lead bronze bearing; the inevitable result will be "pockmarking" of the bearing surfaces. The effect on a reciprocating bearing would be equally undesirable; and it will be readily seen that the jamming effect produced in a ball bearing by the use of this graphite would be ruinous.

For lubrication, the graphite should be such as to permit an infinite divisibility while in contact with bearing surfaces. It should be uniformly fine enough to practically maintain suspension in the oil or grease, so as to permit of the application of the lubricant without undue difficulty due to settling, and it should be fine enough to enter properly between the bearing surfaces without clogging; this will allow it to flow freely in the oil film between the bearing surfaces. For all ordinary lubrication with the lighter grades of machinery oil, none of the graphite particles should be coarser than 0.0003 inch; grades of graphite used with greases or heavy oils would be satisfactory if ground considerably coarser, owing to the correspondingly thicker oil film which exists with these lubricants.

Erecting and Lining Up Steam Engines

This is the Second Article Dealing With Erecting Shop Methods —Placing the Outboard Bearing and the Method of Running the Lines are Described in This Instalment

By "Fitter"

IN the introductory article on this subject we had arrived at the point where the main frame and bearing of the single cylinder engine were set up.

The next step is to set the outboard bearing in its correct relative position, and check up the machined faces of the casting, where the main bearings must be fitted in. In this operation we come to the first and real lining up in the erecting of the engine, and the method employed is practically the same as is used in the engine room.

A line is carried through the cylinder from back to front, extending through the guides and beyond the main bearing, where it is fastened securely to some convenient upright, that is either secured to the floor or is heavy enough not to be easily moved. The line is fastened at the centre of the back end of the cylinder by means of a straightedge or staff laid across the opening. At the front end of the cylinder a staff is secured, with a small hole in the centre. This is usually made by fastening a piece of tin to the staff over a fairly large opening, and marking the exact centre of the cylinder on the tin, through which a hole is made just large enough to pass the line through. At the front end of the bored-out guides a similar staff is placed, and these form guides for the centre line. Great care must be taken to get these staffs exactly central, and if there is any doubt about them it would be better to leave them out and stretch the line from end to end free of any guides.

If the line used is an ordinary builder's line there should be no difficulty in stretching it taut. Some erectors prefer to use a fine wire, which can be stretched tight by a stretching screw or small drum and ratchet gear. Having stretched the line taut, check up with callipers in the cylinder bore and guides to make sure it is central. By holding a long straightedge up against the line and placing a spirit level on the straightedge, a further check can be made.

The next step is to look up the drawing for the distance from cylinder cover to centre of crank shaft and measure this out on the line. Great care must be taken in making this measurement, and the safest way is to employ a long straightedge, such as can be found in most erecting shops, with which the measurement can be made direct. A tape measure is absolutely useless for close work, and a short straightedge, which must be moved half a dozen times in making the measurement, is far from accurate.

If there isn't any such straightedge it will be advisable to get the carpenter or patternmaker to make one. Of course, the straightedge will be marked off in feet only, but the fractions of feet are obtained by using ordinary 12-in. steel straightedge. The spot on the line can be marked for the meantime by tying a colored piece of twine round it, or a plumb bob can be dropped down and its position marked on the floor. This is one point for locating the cross line, or crankshaft centre line. The other end of the line may be located by measurement, or by squaring across from the first line. If located by measurement a straightedge of sufficient length is placed across the cylinder at the back, and the measurement taken from there in the same way as it was taken by the line. In this method care must be taken to keep the measuring straightedge square with the one across the cylinder. This can be done by dropping plumb bobs down from the cross straightedge to the floor and making a chalk line on the floor exactly corresponding to the edge of the straightedge across the cylinder. The measuring straightedge can then be squared off this by means of an ordinary square.

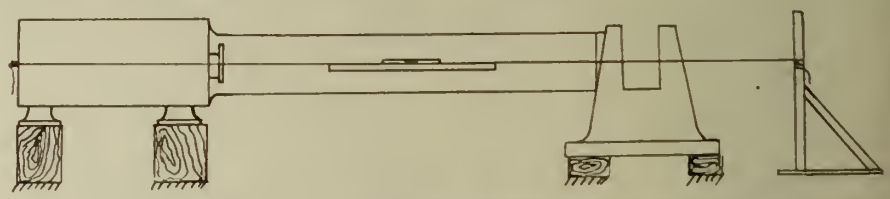
Another method is to measure from the centre of cylinder at the back the distance the straightedge is from the centre, and then measure from the line at the front end a similar distance and lay the straightedge to touch these marks. It is merely a question of parallel lines and different erectors use different means of securing accuracy.

The distance from cylinder face to crankshaft is now marked out, and the other end of the cross line located. It now remains to place uprights at each end to which the line can be secured and these should be capable of adjustment. They are placed as close as possible to the marks found, and the line is stretched across, care being taken to keep it exactly horizontal. The measurements are then checked up again, and any small adjustments that may be necessary are made.

The line can also be accurately located by means of the first line. A straightedge is laid along the first line, just touching it, and a square put against this, the blade, of course, being a guide for the line.

Whichever way the job is done it is, of course, understood that absolute accuracy must be obtained. Measurements must be checked up as the job goes along, and every precaution taken to see that nothing gets moved after being once located. These conditions having been, of course, observed, we have now the two main lines of our engine, the longitudinal axis, and the transverse axis.

The outboard bearing can now be accurately located by means of the cross line. Its centre must exactly coincide with the line and the distance from the cylinder centre line as given by the drawing can be measured off. In the case of a main bearing casting that is bolted to the girder frame it may be found that some little adjustment may be necessary. That is the bearing may be too close to the cylinder or too far away from it. If too close it simply means that a liner has to be put in between the girder and the frame where they bolt together, while if too far away the face of the girder or bearing casting must be planed to let them come together. In a shop where good manufacturing methods are in force this should not happen, but it may. A small discrepancy does not matter a great deal, as it can probably be taken up on the bearing brasses, or in the length of the rods, but it is better to stick to drawing dimensions.



LINE THROUGH CYLINDER AND GUIDES SHEWING STRAIGHTEDGE AND LEVEL.

The inboard and outboard bearing pedestals having been accurately located the lines are left in position and the main bearing and outboard bearing brasses are brought along. These will have probably been machined to fit into the casting, but not bored. They are fitted into their place on the casting and the centre line of the engine is then marked on the brass. This gives a location for the boring out of the brasses and ensures that they will be correct when the shaft is fitted in. The brasses may be bored out before being tried in a shop where they are very sure of them-

selves, but generally it is better to fit the brasses and mark them off after having placed the engine frame.

We will suppose now that the brasses have been bored out and returned to the erecting shop. The lower quarters or halves, as the case may be, are dropped into the pedestals, and the distance from the centre line to the bore of the brass checked up. This, of course, should be just half the diameter of the crankshaft. If it is less, then the brass must be made to suit, either by boring out if it has been bored too small, or if the bore is right by taking some off the outside to let it go down further in the pedestal. If the measurement shows more than half the crankshaft diameter, then the brass must be lined up from underneath to suit. We will suppose, however, that on checking up the distance is found just right. The cross line can now be taken out, and the uprights holding it moved out of the way and the crankshaft brought along by the crane. The longitudinal line will have to be taken out or dropped down while the shaft is being lowered into its place. Before lowering the shaft the journals are rubbed with red raddle, or marking, and the bearing brasses carefully cleaned. It must be noted that while we speak of bearing brasses we do not necessarily mean that they are made of brass. They will much more likely be of white metal with a cast steel shell, but it is merely the technical or shop expression. The shaft is dropped down gently into the bearings, and then, with the help of the crane, oscillated once or twice in place, and then lifted out again. The marks on the bearings are carefully noted, and if there is any fitting to be done in the way of scraping down hard lumps it is attended to right then, and the shaft lowered and raised several times till the bearing surface is correct in the opinion of the man in charge of the job. With the crank hanging down vertically, as it naturally will when left alone, the centre line is stretched again to its place, and the alignment of the crankshaft can be tested. This is done by simply bringing the crank pin up to the line first on one centre and then on the other and noting the position of the line on the pin. It is obvious that if the crankshaft is at right angles to the longitudinal centre of the engine as it should be, and the crank pin is directly central with the centre of the cylinder, the line will lay exactly in the centre of the length of the crank pin, and at right angles to it, and whatever position the crank pin is in the line should always cut the same mark. If it does not the shaft is out of line and must be corrected. However, if the erecting has been done with due care there will be no fear of that.

(To be continued)

The Transparent Rubber Co., on Danforth Ave., Toronto, will rebuild their factory which was recently destroyed by fire.

SPARK ARRESTERS

JOHN S. WATTS

The following appertains to spark arresters for the stacks of stationary or portable boilers only, not to locomotive boilers. A common fault in making these is to allow too small an area for the escape of the smoke, with a consequent choking of the draft, which may be serious enough to compel the removal of the spark arrester before steam can be raised on the boiler, with serious risk of fire until a new and larger one can be procured and installed.

In one case, where sawdust was the fuel being burnt, and the boiler was being operated in a densely wooded district, during the dry season, the risk of fire being therefore too great to permit removing the spark arrester, but with it in place no draft could be got, as it choked up almost immediately after the fires were lit. As a temporary expedient a good marksman was posted with a rifle to shoot at the spark arrester occasionally, the impact of the bullets on the arrester serving to jar the debris off the screen sufficiently to permit operating the boiler.

This method is, however, not to be recommended, the results in a populated district of a badly directed shot being likely to be disastrous to some one, to say nothing of the expense for ammunition.

The neatest and most effective shape for the spark arrester is the elliptic one shown in figure 1, and is built up on a frame made of flat bars, riveted to a band, which can be clamped to the top of the stack. This frame is covered with wire cloth, bolted to the bars of the frame.

For stacks less than 24 in. diameter the frame will be amply strong if made of three bars 2 in. by ¼ in., with a 2 in. by ⅜ in. bar for the clamp ring. For stacks 24 in. diameter and over, use four 2 in. by ⅜ in. bars, with a 2 in. by ½ in. clamp ring.

The wire cloth should have ½ in. square openings in the clear, and be made of ten gauge wire. Experience shows that a spark that will pass through a half inch opening will be extinguished before it reaches the ground. On the other hand, a smaller opening will clog up and choke the draft.

With the wind blowing against one side of the stack the smoke will be compelled to find its way out through the screen on the leeward side, and therefore one-half of the area of the spark arrester should contain an aggregate area of openings equal to the area through the stack.

In other words, the total area of the openings in the screen should be twice the area of the stack. The screen having half-inch square openings and ten gauge wires will have an area of opening equal to .25 square inches in an area of a square whose side is ½ in. plus 9-64-in., or .41 square inches. The area of the openings is therefore 25-41 of the total area.

The total area of the spark arrester therefore must be equal to the area through the stack, multiplied by 41-25 x 2, or 3.28 times the area of the stack.

The area of the surface of the screen is given by the formula,

$$\text{area} = \frac{\pi d}{2} \sqrt{\frac{4h^2 + d^2}{2}}$$

and as the area of the stack is

$$\frac{\pi d}{2} \sqrt{\frac{4h^2 + d^2}{2}} = \frac{3.28 \times \pi \times d^2}{4}$$

where d = diameter of the stack and h = height of screen. Then

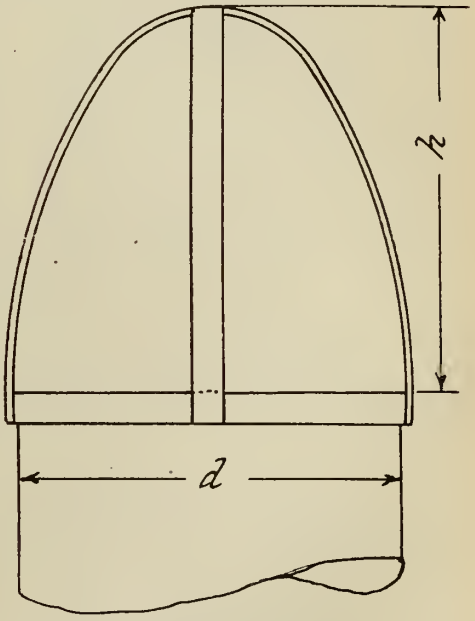
$$\sqrt{\frac{4h^2 + d^2}{2}} = \frac{1.64\ d}{}$$

$$4h^2 + d^2 = 5.3792\ d^2$$

$$h^2 = 1.0948\ d^2$$

$$h = 1.046\ d$$

Or, practically speaking, the height should be equal to the diameter of the stack.



SPARK ARRESTER.

NEW EXPERIMENTAL LABORATORY

Owing to the trend toward higher voltages which is being initiated in the West, and which will ultimately extend to all parts of the United States, the Westinghouse Company is building a complete, modern, high-voltage, experimental laboratory. In this laboratory will be installed two transformers, one rated at one million volts, 1,000 kv-a., the other rated at half a million volts, 500 kv-a. They can be connected together, and one and a half million volts can be obtained between terminals.

This will allow voltages for flashover testing as high as one and a half million volts.

The laboratory will be 120 feet long, 110 feet wide and 50 feet high, without columns of any sort. High-voltage insulators, transformer terminals and circuit breaker terminals will be tested in this plant.

Here We are Again! Perpetual Motion

From the Far Pacific Coast Comes an Inventor With a Solution to the Age-old Problem—He Says it is Perfectly Simple—See What You Think

FOR the last five years I have been trying in vain on both continents to find a man that could give more faith to scientific calculations than to our fallible science. A few days ago an action was received by me from the Patent Office, from which I quote: "Case considered as amended. It seems that there is a saving in the quantity of motive fluid used to compress a given volume of air over that required in a single cylinder. The claims stand allowable." Now this gives me great encouragement, and I ask you to be kind enough and figure out this puzzle with me and tell me how superior this air compressor is, in which there takes place air compression on entirely new lines.

Every one of us knows what an air compressor is. In figure 1 I am showing an air compressing cylinder (A) of an assumed cubic foot of air capacity at atmospheric pressure. It is connected to steam cylinder (B). If we want to compress that cubic foot of air to ten atmospheres of pressure we let steam enter behind the piston of the steam cylinder, and when the piston of the cylinder (A) reaches a certain point (e), at which point the air underneath the piston is found compresed to ten atmospheres, the valve (a) opens, the piston makes its full stroke, and that cubic foot of air is found compressed to ten atmospheres in the reservoir.

A certain amount of steam power in the cylinder (B) was required to obtain this, viz.: 144x150, or 21,600 foot-pounds. Consequently for eight cubic feet of air to be compressed to the same pressure of ten atmospheres the process has to be repeated seven more times. That is to say: 8x21,600, or 172,800 foot-pounds.

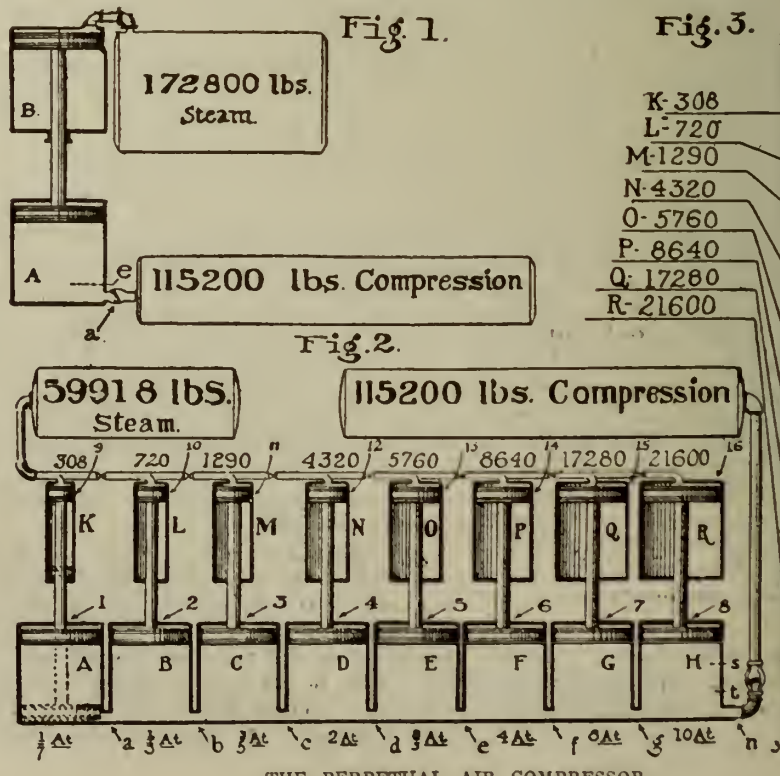
Suppose that we use back those eight cubic feet of air, compressed as we stated to ten atmospheres, viz., as a driving force in another set. We will not obtain back the whole amount of the 172,800 pounds, as some power is lost on account of friction, produced heat and other causes.

Admitting that loss in power to be approximately 30 per cent., as occurs in nearly all air compressors, we will obtain back only a force of about 115,200 pounds.

Now, let us take eight air compressing cylinders of one cubic foot capacity each (figure 2), A, B, C, D, E, F, G and H, and let us have them communicate freely to themselves by the valves or ports (a, b, c, d, e, f and g). To the piston of each of these cylinders is connected in a straight line the piston of a corresponding steam cylinder, which are, respectively, K, L, M, N, O, P, Q and R. The piston of each air compressing cylinder is found at the upper end thereof, so, in admitting air into these eight air compressing cylinders, we have eight cubic feet of air at atmospheric pressure, and running freely through the ports (a, b, c, d, e, f, g) from the first cylinder to the last. First of all, let us assume that the air compressing cylinders are jacketed by cold water, and that isothermal compression is effected, and that, step by step, compression, from left to right, is as follows:

The piston (1) of the first air cylinder makes its full stroke and it displaces or forces the air of the first cylinder to be distributed into the others through the port (a), which port (a) is closed by the piston (1), which stops at the end of its stroke (shown by dotted lines), so the air does not flow back into the first cylinder.

Let us find how much steam power (weight) was required in the first steam cylinder (K) to push the piston (1) of the air cylinder (A) for its full stroke. According to Boyle's law, that the pressure varies reversely to the volume in the compression of air, in our device, where eight cubic feet of air (volumes) are are found crowded into the seven cylinders, B, C, D, E, F, G and H, a pressure of one-seventh of an atmosphere is met. As we assumed above, that for ten atmospheres pressure, a driving force of 21,600 pounds are required, then for one atmosphere pressure a force of 2,160 pounds would be required, and for one-seventh thereof, a force of 308 pounds are required. It is therefore plain that we need only 308 pounds of pressure in order to push the piston (1) through its full stroke. The piston (2) of the second cylinder (B) is pushed down by its connected steam piston (10) of cylinder (L), and at the limit of its stroke closes port (b), so the air will not flow back. Here we have the eight volumes of air crowded into the space within the six remaining air cylinders, and in accordance with the same law we have accumulated one-third of an atmospheric pressure, which corresponds to 720 pounds of steam pressure to overcome the air pressure. At the end of cylinder (C) we have a ratio of three-fifths and consequently need 1,290 foot-pounds in the corresponding steam cylinder (M). The ratio for the cylinder (D, E, F, G) is 2, 8-3rds, 4 and 8 atmospheres, consequently we need in the steam cylinders (N, O, P, Q) these corresponding ft.-pounds, 4,320, 5,760, 8,640, 17,280. Now, underenath the last piston of the last cylinder (H), we have these eight cubic feet of air compressed to eight atmospheres. The piston is forced down and when it reaches a certain point (s), at which point the eight cubic feet of air are compressed to 10 atmospheres, the valve (n) opens and the piston continue its full stroke under a steady



THE PERPETUAL AIR COMPRESSOR.

pressure of 21,600 pounds into the steam cylinder (R).

So we have eight cubic feet of air compressed to ten atmospheres pressure by using a certain steam power, varying in each cylinder. In the first steam cylinder (K) we needed 308 pounds to drive piston (1) a full stroke; in the second, 720; in the third, 1,290; in the fourth, 4,320; in the fifth, 5,760; in the sixth, 8,640; in the seventh, 17,280, and in the last, 21,600. In all, an expenditure the total of 59,918 foot-pounds.

We clearly see, by this new device, as we have compressed eight cubic feet of air to ten atmospheres of pressure by using only 59,918 foot-pounds pressure in the steam cylinder, while if the compression takes place in a single cylinder, then the same amount of air to be compresed to the same pressure, we need 172,800 foot-pounds, effecting a saving by my device of driving force of 112,882 foot-pounds. That means about 300 per cent. efficiency, or, allowing 30 per cent. loss from friction, an efficiency of 210 per cent. The more cylinders employed, the better the result. Many scientists I have consulted, and no one has been able to prove these calculations faulty, but because they lead to over 100 per cent. efficiency, they all draw back and say that science does not admit anything like that.

I possess two letters from two professors. One replied that the fault lies in my believing that I can use different driving force for each one of the cylinders, while the other said that with one cylinder the same results can be obtained. Now, who is right—these professors or the examiners in the Patent Office who sent me the aforesaid action? Can there be a controversy in such matters?

Now, suppose that we want to compress eight cubic feet of air to twenty atmospheres pressure instead of ten atmospheres. Let us see what expenditure of force is required. Do we get the same efficiency, or more? We assumed that to compress one cubic foot of air to one atmosphere by a single cylinder (figure 1) we need 2,160 pounds. To compress it to twenty atmospheres we need 2,160x 20, or 43,200 pounds. For eight cubic feet to be compressed to twenty atmospheres of pressure we need 43,200x8, or 345,600 pounds.

Now, in our device (figure 2), to compress those eight cubic feet of air to twenty atmospheres, only in the last cylinder, we exert 43,200 pounds of pressure, instead of 21,600, which was required for the ten atmospheres. The other ratios for the other cylinders will remain the same as formerly, where ten atmospheres of pressure was required—viz., we have 308 plus 720 plus 1,290 plus 4,320 plus 5,760 plus 8,640 plus 17,280 plus 43,200, which will equal 81,518 pounds of force.

Now, the 345,600 pounds of force required in the single cylinder compression minus the 81,518 pounds of force employed in my device, will leave 264,082 pounds of force saved, or about 400 per cent. efficiency.

But one may ask, "What really takes place here that only you clearly can see?" It is the simplest thing on earth. It needs only a little devination. Let us take, for example, the cubic foot of air of the first cylinder (A). To displace it from the first cylinder we need only 308 pounds of steam pressure in the first steam cylinder (K). This cubic foot of air is compressed in the last cylinder (H) to ten atmospheres pressure without any further expense, viz., if we use back that cubic foot of air being compressed to ten atmospheres, allowing a loss of 30 per cent, there will be left to us 21,600, less 7,200 pounds, or 14,400 pounds, but we actually employed only 308 pounds of driving steam pressure in the first cylinder, so we obtain an enormous efficiency of 4,800 per cent. You see, in the last cylinder all the eight cubic feet of air are compressed to ten atmospheres of pressure by a steam pressure of 21,600 pounds. Now, supposing that we had only one cubic foot of air in the last cylinder, as it happens in figure 1, then, in compressing it to ten atmosphere pressure again, the same steam pressure of 21,600 pounds would be required. You may see, in our device the valve (n) opens when the piston is found at the point (s), while in the single cylinder compression it opens farther down at point (t). So, you see, instead of one, we have eight cubic feet of air compressed to ten atmospheres, while actually we use in both cases the same driving steam pressure of 21,600 pounds.

Again, to displace the air of the second cylinder, we need 720 pounds, and when this is found under the piston of the last cylinder and compressed to ten atmospheres, an efficiency of 2,000 per cent. is attained, and so on down to the last cylinder, where things are reversed and a loss of 30 per cent. has to be admitted, but which loss is overbalanced by the tremendous and more than 100 per cent. efficiencies that we obtain in the first stages of the compression, where the resistance of the air is small and where small pressures are required. I cannot make it any plainer.

Many have told me that by using a long single air compressor of equal diameter to one of my multiple cylinders and equivalent in capacity to the eight of them, that the same results are attained. Now, to this we say that the steam at ten atmospheres pressure is distributed at even density from one end of a long steam cylinder to the other, while in our device, by employing the cylinders (K, L, M, N, O, P, Q, R), we can regulate the steam and employ different driving steam pressure in each cylinder, according to the resistance met in the air compressing cylinders. Do not confuse this device with the stage compression. In a stage compression the air compressing cylinders are not connected freely between themselves. This law that the pressures vary reversely to the volumes cannot apply in stage compression.

In figure 3 I am showing the steam cylinder of an air compressor eight times the length of the cylinder of figure 1. There every one can see that the space (y) of steam cylinder 1, 2, 3, 4 will denote the saving in driving steam. Now, cannot any one of you determine to how much that saving comes, or how far my calculations are correct?—H. Nicholaides, 560 Fifth St., San Diego, Cal.

Editor's Note.—We should be glad to see some comment from our readers on this discovery.

TRADE ANNOUNCEMENT

The Conveyors Corporation of America, formerly the American Steam Conveyor Corporation, Chicago and New York, announce that S. D. Inman has been placed in charge of the engineering and design of their American Trolley Carrier, monorail conveying equipment for handling coal, ashes, sand, gravel, and like bulky materials from railway car to pile, bin or bunker. Mr. Inman is a conveyor engineer of considerable experience and ability, and has been associated with the Conveyors Corporation in an engineering capacity for over a year.

CATALOGUES

We have received Bulletin 19 of the Direct Separator Company, Syracuse, N.Y., describing the steam and oil separators made by that firm. These separators are made in two styles, vertical and horizontal, to suit the particular circumstances of the installation. There are also horizontal and vertical oil separators for low pressure lines and low pressure steam turbines. The catalogue is full of information with diagrams showing installation space required, shipping weight, etc. The Direct Flanged Steam Fittings are described in another catalogue issued by the same company.

The Progress Products Company, Philadelphia, have issued a folder describing their Producto Combustion Guide. This device is a combination of steam flow meter and multiple differential draft gauge. It is claimed that it is easy to read, rugged in construction, readily adjustable, and entirely new in principle.

The Holden Company, of 354 James St., Montreal, are distributing to the trade a very attractive calendar of the Chicago Pneumatic Tool Company. The calendar is printed on coated stock, 12 inches wide by 24 inches deep, the upper section of each page carrying a large reproduction of one of the applications of one of the company's air-operated tools. The entire calendar is neatly arranged and well deserving of a place in any engineering office.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

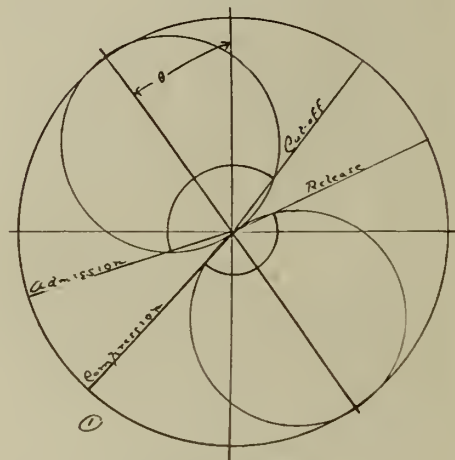
IT will be noticed in diagram shown in our last issue that the events on only one side of piston were shown. The events on the other side could be shown in just the same way, on the same diagram, or on a separate one. In showing the events on the same diagram the outside lap circle for the crank end would be laid off on the lower valve circle, and the inside lap on the upper. If cut-off was to take place on the return stroke at the same point as on the outward stroke, correction of the outside lap would have to be made accordingly. This would be done by laying off the necessary position of crank to correspond to position of piston at required cut-off, according to the length of rod. Then the point at which the crank cuts the valve circle would be the radius for the lap circle. This is illustrated on the accompanying diagrams.

Effect of Altering Laps

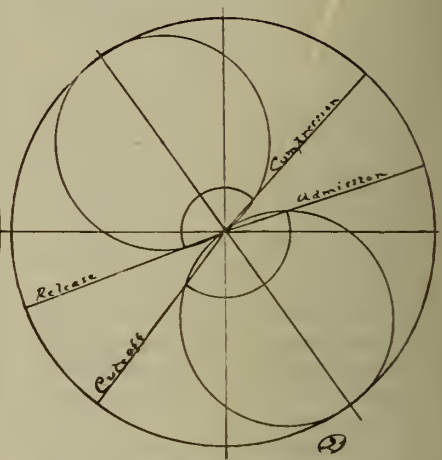
Supposing that we increase the outside lap. The events at that end of the cylinder, the eccentricity, remaining the same, would be altered in the following manner. Lead would be later, and cut-off earlier, as can be plainly seen from the diagram as compared to the original. Increased inside lap will make release late and compression early. Conversely, decreased lap outside will make admission early and cut-off late, while decreased inside lap will make release early and compression late. These effects can be seen quite plainly on the diagrams.

Altering Advance of Eccentric

Now, if instead of decreasing or increasing the laps on the valve itself we were to move the eccentric either further away or closer to the crank we would immediately have effected a change in every function of our valve, at both ends of the cylinder. If the eccentric were moved ahead, or, say, further in advance of the crank, we should have every event occurring earlier in the stroke. A moment's thought will show that this must be so. Increasing the angle of advance means that with the crank on the dead centre, the eccentric is closer to its extreme outward position. This means that a very short travel of the crank brings the eccentric past its extreme point, and the valve moves in towards its cut-off position so much earlier. Steam is cut off sooner, and the eccentric, still traveling towards its other extreme position, opens the valve to exhaust at a correspondingly earlier position. It reaches its extreme position and starts to return,



HEAD END DIAGRAM.



CRANK END DIAGRAM.

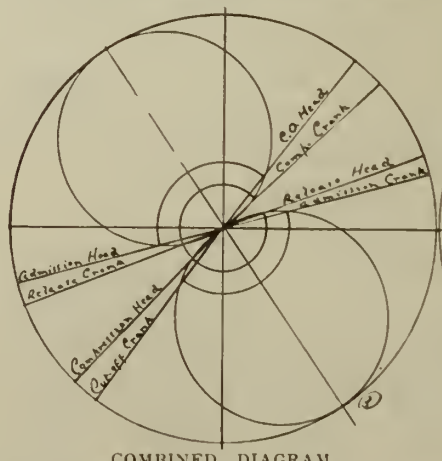
closing the exhaust while the crank is still comparatively a long distance from the end of its stroke. Thus, we have early lead, early cut-off, early release, and early compression.

Moving the eccentric back towards the crank or decreasing the angle of advance has exactly the opposite effect to that just noted. We would get late lead, cut-off, release and compression.

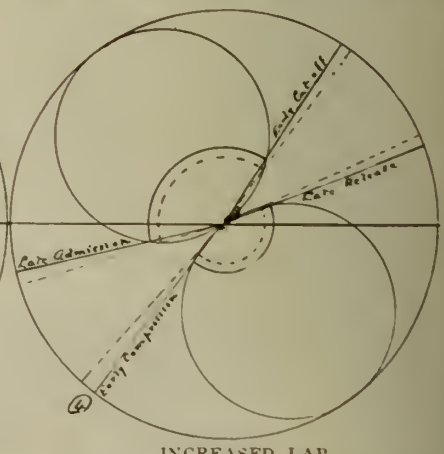
Increasing Eccentricity

If we increase the eccentricity, we shall, of course, increase the travel of our valve. The lead will be greater, that is, admission earlier. The cut-off will be later, release will be earlier and compression later. In other words, we shall have greater port openings.

By comparing these different diagrams



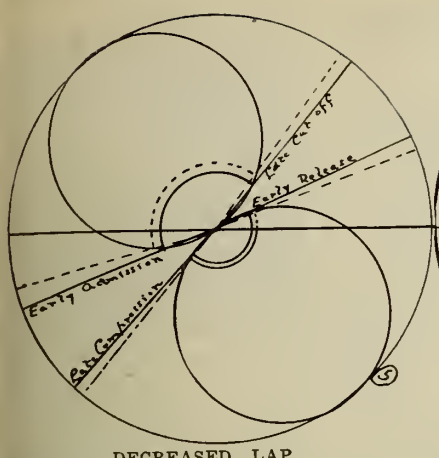
COMBINED DIAGRAM.



INCREASED LAP.

the various effects can be plainly seen. Supposing now that we have a valve that has become misplaced on the spindle. We will suppose that owing to wear the gear has all moved closer to the eccentric, bringing the valve with it. Now the travel remains the same, the angular advance remains the same, and the only thing altered is the position of the valve relative to the crank. The effect is precisely the same as decreasing the outside lap at the top, and increasing the outside lap at the bottom. The inside lap at the top will be practically increased, and at the bottom decreased. We shall have at the top early lead, late cut-off, late release, and early compression. At the bottom will be late admission, early cut-off, early release and late compression.

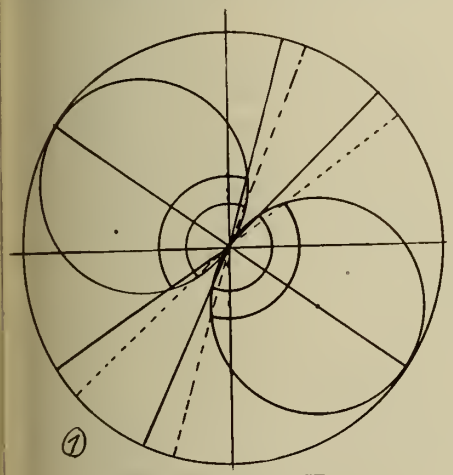
There are other valve diagrams, but they are all on much the same principle as the Zeuner, and it is easy to follow any others if the Zeuner is well understood. Careful study of the diagrams here reproduced will make it quite clear to all how the steam distribution is affected by alteration of any part of the valve or eccentric. These effects are clearly shown on the indicator cards, and thus we have two very important aids to our study of the valve. The diagram



DECREASED LAP. LAP CORRECTED FOR CONNECTING ROD.

shows us clearly and with but little effort just what will occur to the steam distribution under any given circumstances. It then becomes an easy matter to arrange our valve and eccentric to give the results shown on the diagram.

The indicator card, on the other hand, is a diagram of what the valve is actually doing at the time the card is taken. The various events are clearly shown, and it is then easy to see just how much the performance of our valve is varying from what it was designed for. The necessary measures to correct the faults are also clearly indicated. In order to illustrate this clearly in our next article



ECCENTRIC ADVANCED.

we will take an indicator card, drawn from a Zeuner diagram, and then show the effect of the various changes on the indicator card.

SECURING PROPER LUBRICATION

Sluggish action of oil-rings leading to improper lubrication of motor bearings was cured by bevelling the sides of the rings of motors made in a large New Jersey factory after considerable searching for the reason for the trouble. On testing these motors, says Electrical World, it was noticed that the ring would creep along at a very slow speed, two or three revolutions a minute on a machine of several horse-power, instead of the regular speed of about thirty to fifty revolutions. Though all journals and rings were made in large numbers and as nearly alike as possible, this trouble appeared on only about one machine out of ten, and disappeared nearly every time a new ring of the same size and shape was put in. Sometimes, of course, it was due to the ring rubbing against some projection on the casting, but more often no apparent cause was found by the assembling department. At that time the oil-rings were cut from a rather heavy brass tube with straight sides, making the cross-section rectangular in shape, while the journals had a straight slot about twenty to twenty-five mils wider than the ring.

It was finally discovered that under certain conditions the ring would start with the machine and perhaps come up to normal speed, but soon work itself towards one side of the slot and slow down, hugging closer and closer until there was only a very thin film of oil between the ring and the flat part of the journal.

Therefore, in an attempt to prevent sticking, three rings were removed and their sides were slightly bevelled, when the trouble entirely disappeared. Since that time all oil-rings are bevelled either from the outside or from the inside, and there has been no sticking.

POWER FROM WASTE WOOD

The progress which has been made by British firms in the construction of suction gas plants for utilizing waste wood should be of special interest to this country, where there are still large quantities of wood available. These plants distil the wood and produce gas which is of excellent quality for use in gas engines. This method of utilization is said to be more economical for power producing purposes than burning under a boiler. A recent example of a large installation on these lines is afforded by a mine in a British Dominion, where four suction gas plants capable of yielding a total output of fourteen hundred horse-power have been installed. The fuel used is in the form of logs up to two feet long and a foot in diameter; and the gas is applied to the driving of four horizontal gas engines. Three of the engines drive electric generators and the fourth is coupled to an air compressor for operating pneumatic drills and hammers in the mine.

GOING AHEAD TO LOCATE COAL

Reports of provincial analysts and other kinds of geologists have not cooled the ardor of those who believe there is coal around Shelburne, Dufferin County.

A while ago investigations were made, and as a result a very discouraging report was made to the effect that the chances of finding coal in such surroundings were nothing at all.

The sequel comes in this announcement in the Official Gazette:

Two million dollars is the authorized capital of the Chamberlain Coal and Oil Development Co., Ltd., which has been granted letters patent and will have its head office in the village of Shelburne.

The new company under its charter is authorized (a) To acquire, own, lease, prospect for, open, explore, develop, work, improve, maintain and manage mines and mineral lands and deposits; and (b) to take, acquire and hold as consideration for ores, metals or minerals, including oil and gas, sold or otherwise disposed of, shares, debentures or other securities and to sell and otherwise dispose of the same; with a capital of two million dollars, divided into two million shares of one dollar each; its head office at the village of Shelburne, in the county of Dufferin.

The Combustion Engineering Corporation, New York, have issued a most attractive calendar, which is a beautiful specimen of color printing. The various months are headed by a colored engraving depicting various types of stokers, and also a pulverized coal installation. The types of stokers include the type E, the Coxe, Lopulco Pulverized Fuel System and the type H, all products of the Combustion Engineering Corporation.

STATISTICS OF POWER USED IN 1918.

Provinces.	No. of Establishments	Steam Engines No. of Units	Steam Engines Total H.P. actually used	Steam Engines Aver. H.P. per unit	Water Wheels. No. of Units	Water Wheels. Total H.P. actually used	Water Wheels. Aver. H.P. per unit
Alberta	1,252	230	39,271	170	18	31,672	1 759
British Columbia	1,786	785	90,183	115	157	255,029	1.624
Manitoba	1,444	284	32,195	113	18	63,710	3,540
New Brunswick	1,364	504	46,131	91	99	13,944	140
Nova Scotia	2,125	674	66,770	99	300	18,274	61
Ontario	15,365	3,243	252,580	80	1,275	807,583	633
Prince Edward Island	484	75	1,838	24	46	870	19
Quebec	10,540	1,732	117,229	68	1,318	818,117	620
Saskatchewan	1,422	174	29,410	170	8	140	18
Yukon	15	6	420	70	2	5,000	2,500
Totals for the Dominion	35,797	7,705	676,027	88	3,241	2,014,339	621

POWER HOUSE

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Canada Keeping Up

THE opening article in this issue of Power House is a description of a Canadian made Diesel engine. This is not the first description of a Diesel engine that has appeared in the pages of Power House, but it is the first time that a Canadian made Diesel has been described for the very good reason that it is the first engine of this kind built in our Dominion.

This engine is running daily, and is a successful commercial article. Other firms in Canada are developing other types of internal combusion engines, so that we are not likely to be behind the rest of the world in this particular development. There are a large number of places in Canada where the Diesel engine or its near relation, the hot bulb engine, can find a very useful sphere. With the discovery of what appears at first glance to be the largest oil field in the world at Fort Norman in North-Western Canada, the development of the country will be hastened in every direction.

It is time for the power plant engineer to familiarize himself with these engines as far as he possibly can, so that he can step into the breech when needed.

Protecting the Fireman

IN a recent issue of a journal which specializes in technical subjects arranged for the understanding of the layman, there appeared recently an article of interest to the engineering profession.

From this it appeared that the man who is engaged in the task of generating steam in the boiler by shovelling coal is frequently inconvenienced by the heat. This is somethin we have noticed ourselves, but it is nice to have it confirme by such an authority. We must confess, however, that th way to avoid this inconvenience had not previously suggeste itself to us. This is all the more remarkable as it appear so simple. All that is required is to make the furnace door and fronts hollow, and through the passage thus forme circulate cool and refreshing water. The author goes furthe and says this system can be applied to other parts of th boiler. Why of course it can! When we come to think of i there are lots of places it could be applied. For instance imagine what a delightful place the boiler room would be come were the shells of the boilers jacketed before the lagg ing was put on. The steam pipes could be run through larger pipe, with circulating water in the space betweer There would be all kinds of comfort in the boiler and engin room then.

However, we always had the idea that all the heat possible should be retained in the boiler and steam pipes. Th method of keeping boiler furnace doors cool always seeme to us to be by keeping the fire clear of the dead plate, as w always found that burning coal on the dead plate didn' help the generation of steam greatly. On the other hanc it was good for the manufacturer of arch bricks, furnac door baffle plates, etc.

Again we must confess, however, that the simple ide of a water jacket never entered our head.

It Crops Up Again

SOMETIMES we think the type of inventor who believes h can get more out of a machine than he puts in has die out. Then suddenly our hopes are shattered, and from ou of the void comes a voice crying "Eureka! I have found it." Needless to say the owner of the voice only thinks he ha found it. It isn't there to find.

In another part of this issue we print an account by one N Nicolaides, of a machine, or principle, by which he claims h can do roughly 173,000 foot-pounds of work in an air cylin der by the expenditure of 60,000 foot-pounds in the steam cylinder. The method he proposes is somewhat involved, an requires careful reading before his idea is grasped. How ever, we still believe that Baylis Law holds good, our inven tor to the contrary notwithstanding. He traces back the pro phecy of his invention through the shades of Greek myth ology, leading up to a vision which was vouchsafed to him which started him to thinking deeply. The outcome of hi thoughts is the fearful and wonderful discovery described o another page.

This inventor is generous. He wants no reward but re nounces his claims freely to the government and the people He wishes the government to proceed gradually with th manufacture, as he does not wish existing industry to b shattered at one fell swoop. He is quite ready to appea before a body of scientists and engineers, and if he does no convince them, will voluntarily retire to an asylum. Tha would seem to us to be a wise step.

The machine has never yet been built by man which is 100 per cent. efficient, let alone over 100 per cent. We doub very much that it ever will. The fundamental principle tha you cannot get more out of a machine than you put in re mains as immutable as ever. If ever that condition shoul be changed, then indeed would this world, in the words o Mr. Nicolaides: "Be transformed from a vale of tears to a veritable Paradise."

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

ZEUNER DIAGRAMS AND CALORIMETERS

Question.—Would you kindly explain the Zeuner diagram and also the principle of the steam calorimeter?

Answer—The Zeuner diagram has been explained in the last issue and also in this issue in the Course of Instruction. Calorimeters are of two kinds, the throttling and separating types. In the throttling calorimeter steam enters an upper chamber and passes to a lower chamber through a diaphragm. In the top chamber a thermometer is placed, and also in the lower chamber. The passage of the steam from the top chamber to the lower one through the diaphragm is restricted by the small orifice in the diaphragm, while the outlet from the lower chamber is large, and to the atmosphere. Therefore, the steam coming from the top chamber is wire drawn, and superheated by reason of it expanding without doing work. The reading on the lower thermometer will give the amount of this superheat, and if there is moisture present in the steam the superheat will be less, on account of part of the heat of the steam having gone to evaporate the moisture. The following formula will give the degree of moisture in the steam.

Let.

T=Temper. of steam on high press. side;
t =Temper. of steam on low press. side;
H=Total heat of steam in upper chamber (H.P. side);
L=Latent heat of steam in upper chamber (H.P side);
q =Heat of liquid in upper chamber (H.P. side);
C=Specific heat of superheated steam at exhaust pressure;
x=Initial quality of steam;
1—100x=initial moisture in steam p.c.

The total heat of a pound of wet steam flowing into the orifice is $xL+q$ and after expansion assuming that all the moisture has been evaporated the total heat of the same weight of steam will be $H + C\ (T—t)$.

Then if no heat has been lost these two quantities should balance each other and we get the equation

$$xL + q = H + C\ (T — t)$$
$$\text{and } x = H + C\ (T — t) — q.$$

The orifice is from 1-16 to 3-32 diameter, and the weight of steam discharged per hour can be found from Napier's formula $\frac{PA}{70}$ equals the pounds per second where P is gross pressure and A is area of orifice. The use of this type is restricted to cases where the steam only contains a small percentage of moisture, say up to 5 per cent.

For cases where the moisture content is higher a separating calorimeter is used. In this instrument the moisture is separated from the steam by a process similar to that taking place in an ordinary steam separator. The total amount of steam flowing can be found from the area of the orifice by Napier's rule, and the ratio of the moisture to the total amount is, of course, the moisture content. A pressure gauge with two scales is attached to the instrument, and this shows pounds of steam per minute according to pressure. A scale is sometimes supplied which reads on the gauge glass the amount of moisture in pounds per minute passing through. If this is not on the instrument, the condensation discharged from the instrument can be weighed and corrected against the average weight of steam over a certain period.

BOILER RATING

Question—Would you kindly answer the following question through Power House. A third-class stationary engineer's license allows the operator to run a plant up to 300 h.p. Now suppose we take a 300 h.p. boiler and increase its rating to 200 per cent. Will the new license law still allow a third-class licensee to operate the boiler?

Answer—The rating of a plant for the purposes of the license law is based on the heating surface corresponding to a boiler horsepower according to the style of boiler. Thus, a H.R.T. boiler is rated at 15 square feet to a horsepower, a water tube boiler at 10 sq. feet and so on. Now it is quite obvious that no matter how much the rating of the boiler may be increased owing to increased combustion, the heating surface will remain the same. The evaporation per square foot of heating surface increases, but that does not affect the rating of the boiler so far as the license law is concerned. If it were possible to force the boiler to 1,000 per cent. rating it would still be a 300 h.p. boiler as interpreted by the law.

AN ELECTRIC GENERATOR QUERY

Question—We have a 30 K.W. alternating generator and a 2 H.P. D.C. generator. The reading on the name plate of the D.C. machine is R.P.M. 1625 plus or minus 5 per cent., 2 H.P., 15.6 amps. When the load is as high as 22 amps. it is hard to raise the voltage only by turning the rheostat over a number of sections, may be as many as six, before the voltmeter shows an increase. With 10 amperes it works fine. There has always been a wave in the machine light, which made me think the D.C. machine was running too slow, so I speeded it up a little and made some difference. Would like to know what the plus or minus 5 per cent. means. Does it mean to increase the speed of the machine after the 15.6 ampere mark is reached, and is it a good thing to increase the speed of the machine?

Answer—With a load of 22 amps. you have a considerable overload on the machine, and it will necessarily make it hard to raise the voltage. Increased speed gives increased voltage by increasing the field strength. The marks on your machine may mean that the generator is designed to work within those limits of speed over or under the normal, or it may refer to the over or under compounding of the field winding. It would simplify matters if you were to give more information about the D.C. machine, its style of field winding, and the purpose it is used for. Also just what do you refer to when you say there was a wave in the machine light? Remember, when you write in a question like this that we have not got the installation in front of us like you have, and therefore we need all the information you can give in order to give an intelligent reply.

LIFT OF PUMP VALVES

Question—Would you kindly advise in your next issue what lift pump valves should have according to size. If not properly adjusted would it affect the stroke of the pump?

Answer—Pump valves are usually arranged to have not more than about 3-16 to 1-4 inch lift on large sizes, and from 1-8 to 3-16ths on small sizes. The valves are made of sufficient diameter to equal the area of the cylinder with this amount of lift. Generally speaking, the smaller the lift the easier it will be on the valves, and the longer they will last. The de-

livery valves are sometimes made with a little less lift than the suction in order to obtain a higher velocity of discharge. The effect on the stroke of a pump would not be noticeable unless the suction valves, for instance, had too little lift. Then the pump cylinder would not be filled on the suction stroke and a jerking action would result. If the delivery valves have too little lift, the pressure will be raised in the pump chamber and the pump would slow down. In some pumps the valves are made very small and a large number of them put in, and the lift made smaller than usual.

CHAIN SLINGS AT AN ANGLE

Question—Could you give me a formula for the stress in the links of a chain when lifting at an acute angle, as for instance, in lifting a cylinder cover with two chains attached to one central hook, or with one chain with the hook in the middle?

Answer—This is a question that sometimes comes up, and is somewhat difficult to answer. At first glance, one would say that a chain being a flexible body, is under no strain except that due to a direct tension, whichever position it may be in. The case of the lift being made by two separate slings, or practically two legs, approximates closely to a chain having a direct tension. If the chain is fastened across the top of the lift and caught by the lifting hook in the middle, then the case is different. The link which is caught by the hook is subject to a bending moment and also a compressive stress, instead of the direct tensile stress which it is usually subjected to. It is difficult to make a hard and fast rule, but would say that when a chain is to be used in the manner last indicated, an ample margin of safety should be taken. With a chain lifting at a slight angle as in the first case, the load should be assumed to be two-thirds the total load in each leg, instead of one-half, with two chains. If any of our readers have made a mathematical investigation of this subject, we should be glad to hear from them.

C.A.S.E. ACTIVITIES

An interesting evening was spent at the Toronto Lodge of the Canadian Association of Stationary Engineers, on Wednesday, the 23rd February. The occasion was an open meeting, and a goodly number of the members and visitors turned out to hear a lecture on the Diesel engine delivered by Mr. W. Brown, of the Dominion Steel Products Co., of Brantford.

Mr. Brown, who is the designer of the engine built by his firm, and which is described in another part of this issue, gave a very lucid description of the Diesel engine in general, and the particular engine designed by him. He handled the subject in an entertaining manner, and all those present were able to fuly grasp the principles elucidated.

The executive officers of the lodge are to be congratulated on their initiative in securing such an interesting event for their open meeting.

We understand that the lodge will be holding a banquet during this month, particulars of which will be given later.

NATURAL GAS AS FUEL

By Elmer S. Hodges

There exists in the West with Medicine Hat as a centre an immense field of natural gas which is obtained from wells averaging 1,000 feet in depth, at a pressure of about 500 pounds per square inch, with a volume of 2,500,000 cubic feet per twenty-four hours. This is a fair average of fifteen wells. The constituents of the gas are CH_4 99.49 per cent., H_2O .51 per cent., or about 89 per cent. methane and 10 per cent. carbons. Tests show 1,150 B.T.U. per cubic foot, against 57 per cent. methane and 600 B.T.U. for coal gas. A very much greater quantity of air is required for combustion owing to the very high percentage of methane, consequently a smaller quantity of gas is used per unit of work done.

The gas has little or no odor and when combustion is properly carried out leaves no residue on boiler or brickwork. A reducing valve is installed at the well, and the gas enters the mains at a pressure of ten ounces and is delivered to power plants at about 6 to 8 ounces. The burners in use vary from a piece of iron pipe with holes punched in it to the highly finished adjustable burner. In the furnace a chequer brick wall is built close to the discharge point, and this becomes red hot when it acts as a refractory and ignition wall. To change from coal to gas requires but little adjustment. All that is needed is a layer of brick on the bars, or closed ashpit doors, so that all the air for combustion must pass through the burner. Practically all types of boilers are operating with this fuel. It is usual when boilers have to be banked up to leave a small pilot burner which supplies enough heat to keep steam up near the working pressure. There are also regulating valves which adjust the burner to changes of load, and will keep the steam pressure up to within a variation of 3 per cent. up or down.

The writer has noticed cases where coal fired boilers after being changed over to gas have developed bagged tubes and plates, and has been somewhat at a loss to account for it. After the defects have been repaired no further trouble has been experienced. The writer has formulated a theory for this notwithstanding the opinion of leading engineers that the cause is nothing more than dirty heating surfaces. He would welcome other opinions.

The gas is also used in steel mills for heating ingots, in glass works for heating retorts ,and also of course for gas engines. Heating and lighting are two of its most important uses. The cost of the gas is 5 cents per thousand cubic feet for industrial users, and 15 cents less 10 per cent. to domestic users.

Round houses find the gas most useful, as, besides supplying the fuel for the power boilers, it is piped round the house and used for tire shrinking, heating frames previous to straightening, melting babbitt right at the job, and so on. It is used also for raising steam on boilers when they are ready to go out. When this was first tried, the correct position for the burners was not realized. They were first placed under the grates, with the result that several grates were burned out. The next position tried was under the coal on top of the grates, the result being the burning out of the burners themselves. The final position was on top of the coal, which is laid on the grate ready for lighting up. Natural gas is also used for lighting Pullman cars, as it mixes quite well with the Pintsch gas and gives good results.

The gas field has been exploited for about fifteen years without any sign of exhaustion.

HOLDING A PULLEY

By J. Ellethorn

When a split wood pulley slips on a shaft and tightening up on the bolts fails to hold it, a piece of sandpaper or emery cloth is placed around the shaft, with the grit side next the shaft, the pulley being placed over it.

There can be no doubt that some writers advising the use of this plan have succeeded in making a satisfactory job, for temporary use at least.

In case the pulley is in a location where oil or greasy vapor can come in contact with it, the grit on the paper will become separated from its base when the oil works in, and a slipping pulley will result. I have seen two cases of this description where the pulley slipped for a considerable time, and the grinding effect on the shaft was so bad that the pulley had to be moved to a different part of the shaft. When the bushing in a split pulley becomes oil soaked, so that it will slip even when quartered, I would advise the use of coarse fibre wrapping paper instead of sandpaper. Then, if there is a slip, no damage will be done to the shaft.

CIRCULAR SLIDE RULE

In order to assist engineers to calculate the size of pulleys and width of belts for transmission problems, a British firm has developed a circular slide rule by which all the details required can be ascertained with rapidity and accuracy.

The death occurred on February 26 of G. R. Baker, 615 Huron St., Toronto, who for many years had been a member of the engineering firm of Westman and Baker. He was an active member of the Lakes Association of Muskoka, and commodore of the Toronto Canoe Club.

Regulating Overflow in Hydro Power Plants

Various Methods Used in Modern Hydro-Electric Stations are Described in This Article, Together With Some Features of Their Operation.

By F. A. SWEET

ARRANGEMENTS for wasting excess water are provided by the use of Taintor gates, sluice gates, bear trap gates, automatic rolling gates, automatic flash boards and gate or flutter valves located near the bottom of a dam.

Wide spillways without gates are also used to waste excess water. When flash boards are installed their purpose is rather to increase the effective head and storage of the river than to waste water. This also may be said of needle stop logs, excepting where they are used instead of gates at the older dams.

Taintor gates are now one of the most widely used gates. They can be raised or lowered easily, as the pressure of the water is taken care of with bearings.

Either hand, motor or interchangeable hand and motor driven hoists are used to operate them. When each gate is not provided with an individual hoist a track is laid on top of the dam to carry a portable hoist. Care should be taken with this type of gate to prevent logs or large cakes of ice jamming them, and that the lifting chains pull equally, otherwise the gate may be wrenched out of shape, which will interfere with their successful operation. Turn-buckles are used on these chains for adjustment. Stop log grooves are usually provided in the dam structure to facilitate work which would require that the water be shut off from the gate. It is difficult to fit stop logs so that no leaks appear, but these can be stopped with cinders.

A wide variety of sluice gates are in use. When these gates are provided at the crest of the dam they are often lowered to waste water. They are therefore very convenient for sluicing ice, logs and other river trash.

It is usual to find booms which bypass this trash into racks. When these gates are built primarily for discharging trash they are sometimes built rather small, so that a minimum of water is used in discharging the trash.

Rack and pinion operated gates are in common use. One or two rack stems are bolted to the gates and the pinion can be back geared for motor, manual or interchangeable operation.

If the gates are designed for hand operation, either hand wheels, cranks or levers are supplied. Some sluice gate hoists have arrangements provided to shift gears so that the operator can select the gear ratio best suited to the conditions. Where a worm or gear is used in the hoist it is convenient because it holds the gate in any position without the use of a brake or stopdog. These gates can be built bearing on rollers so that there is much less friction.

Sluice gates located near the bottom of a dam are very convenient for wasting water in a freezing climate, as the operating stem is the only part which freezes fast and this is not hard to chop free.

These gates waste a large amount of water for their size. For example, a four by four gate at a depth of 29 feet discharges 430 cubic feet per second. This type of gate has been used to render a double service at plants where the tail water rises high enough to curtail the station output during floods. The gates are located so that the water discharging into the draft tube results in an increase of power output of the turbines.

Some sluice gates are provided with adjusting wedges to take up the water if the gate becomes leaky after long usage. These submerged sluice gates are very similar to large gate valves which are also used for similar purposes, so it may be well to consider them at the same time.

Both rising and non-rising spindles are also used to operate these gates in which case remote control by means of valves can be resorted to, or a motor operated valve near the gate can be controlled from a distant point, such as the power or gate house.

Overflow or bear trap gates are raised and lowered like a trap door, being hinged on the lower edge. Chains or cables are used to lift them. They are built very wide at some installations, where it is necessary to sluice large trees or cakes of ice.

Automatic rolling gates are not used very extensively. They are operated by the pressure of the impounded water. When the water rises the increasing pressure on the lower side of the gate turns it over, so that the water flows under it and above it until the head water reaches normal again, in which case the gate swings in the closed position.

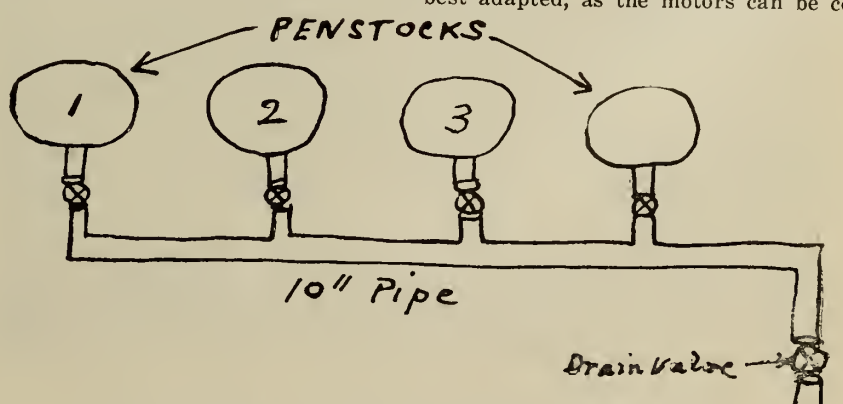
Automatic flashboards will be described as used at the spillway of one dam. The flashboards are similar to a bear trap gate hinged on the lower edge and controlled by rolling counterweights so arranged that the elevation of the reservoir rises only 3 inches when the battery of flashboards waste 12,000 cubic feet of water per second.

The counterweights are concrete cylinders 26 feet long and 3.25 feet in diameter and are fitted at each end with heavily geared rolling contacts, which roll on especially curved racks attached to the side of the piers above the crest. As the flashboards are lowered, owing to the pressure of the water the counterweights are forced up the incline by the pull of steel cables wound on a drum at either end of the counterweight and connected to the top of the flashboards. Hand-operated hoists are provided to manipulate the flashboards if a different reservoir elevation is desirable from that which the flashboards maintain automatically.

Butterfly valves are often called pivot valves. They are either hand, motor or hydraulically operated and are usually located near the bottom of a dam, like submerged sluice gates and gate valves. They will not freeze here unless exposed too much on the down stream side of the dam and waste a large amount of water for their size. One dam is provided with two butterfly valves 100 feet below the crest of the dam. They control the outlet of two 6-feet steel pipes and can be used to drain the reservoir, if necessary, as well as to waste excess water. At normal head water elevation they discharge about 1,500 cubic feet per second.

What has been said regarding gates in general will also apply to head gates which are located at the head of flumes, penstocks or tunnels.

Gates are placed at the head of a flume to regulate the water flowing into it. In this case electrical operation is best adapted, as the motors can be con-



ARRANGEMENT OF BYPASS CONNECTIONS TO PENSTOCKS.

trolled from the power house or by the use of a float switch.

At many developments filler valves are used to fill the penstocks before opening the head gates. These may be small valves or sluices built in the head gates or valves and piping arranged to connect an empty penstock to the forebay or an adjacent penstock which is full.

These valves serve a double purpose. First, they fill the penstocks slowly to prevent dangerous penstock pressures or water hammer. Second, they equalize the pressure on the head gate when the hoisting equipment provided is not capable of opening them under pressure.

The diagram shows how these valves may also be arranged to serve as drain valves when the pipe connections to the penstock are placed to drain the seepage from a closed head gate, thereby preventing this seepage from reaching the turbine where it would hamper the inspections or repairs under way.

When a penstock is filled the drain valve is closed and water is taken from any penstock which is full.

Where filler valves are not provided it may be necessary to open the head gate partly and then wait for the penstock to fill slowly, thus eliminating that high pressure and water hammer, as mentioned before.

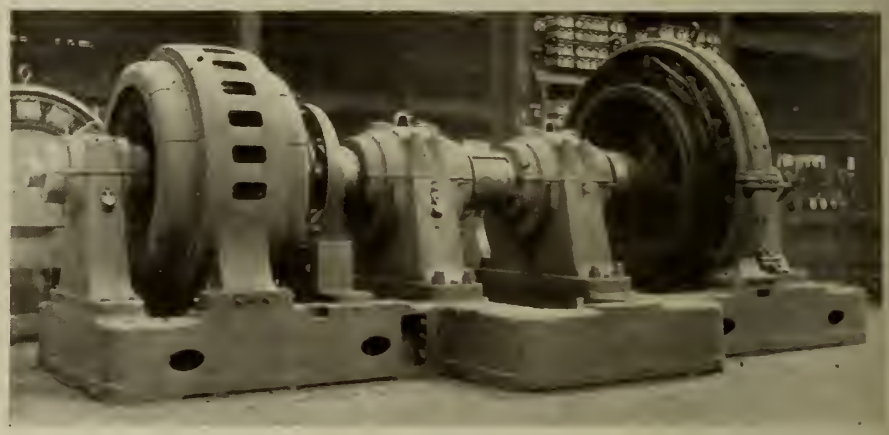
At one installation the gates are equipped with automatic control devices consisting of a limit switch geared to the sluice gate stems and a float actuated

(Continued on page 45)

New Universal Plate Mill

Technical Details — Construction Work—Electrical Equipment, and Various Other Features.

By J. H. Moore



THE FLYWHEEL MOTOR GENERATOR SET WITHOUT THE FLYWHEEL

THE universal plate mill just installed at the plant of the Dominion Foundries & Steel, Ltd., Hamilton, Ontario, will give Canada a mill of sufficient size to produce large plates, that heretofore have been imported through necessity. This mill, as already stated, is of the universal type and will roll universal plate from 7 inches to 41 inches, shear plate to 64 inches, and will roll both slabs and billets. At the present time all kinds of structural plates for bridges, buildings, cars, heavy pipe skelp, sheet bars, etc., are imported. These imports amount to hundreds of thousands of tons annually but the addition of this mill should help such work in our own country.

It is also intended to roll slabs and forging billets to furnish stocks for their own plow and jobbing mill, also their axle forge shop. These two departments have already been in operation for over two years. The new mill will also roll special forging billets or blooms, such as are used for locomotive, ship, and other heavy forgings. By removing the side rolls of the mill, sheared plates up to 64 inches can be rolled. It can also be equipped with blooming rolls for rolling billets, and a manipulator is installed to take care of this when used as a blooming mill.

At the close of the war this company found itself with a steel making capacity of over 12,000 tons per month; a large modern foundry; a heavy forge shop; a 22-inch bar mill; an axle shop, and a 26-inch jobbing mill. This latter mill was turning out soft center and solid plow steel, automobile frame steel, and jobbing plates, and it was realized that additional finishing capacity was absolutely necessary, not to speak of the need of equipment for the breaking down of the ingots for the existing finishing departments. After careful consideration, it was decided to install the plate mill about to be described.

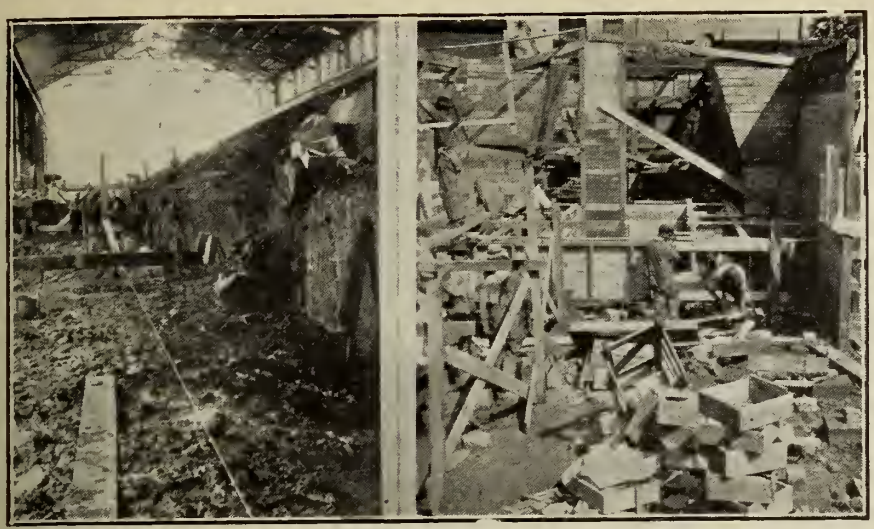
The mill itself is made by the Mackintosh & Hemphill Co., Pittsburgh, and is technically known as a 27-inch universal plate mill. The horizontal chilled iron rolls are 72 inches in length, with an extreme vertical lift of 20 inches. The vertical rolls both front and back are 18 inches in diameter, and have an opening range from 7 inches to 41 inches. The rolls are operated by hydraulic pull-backs, and the screw downs on the rolls are electrically operated. The main screw downs have two 60 h.p. compound wound motors in series, while for each set of side screws, there is a 40 h.p. motor of similar type.

The housings are cast steel of very rugged proportions, and many other principal parts on the mill are made from the same material. The pinions for both the horizontal and vertical roll drives are enclosed in oil type housings, and all these pinions have machine cut, helical teeth. The main screw down motors are mounted on the pinion housing cap, while the side screw motors are located in a pit at the side of the mill.

Provision is made for removing the side roll housings and inserting a short section of driven rolls both front and back, this allowing the rolling of shear plate up to 64 inches. This system of removing the side housings is also necessary when using as a blooming mill. The illustrations shown throughout the article are taken from various positions, and the details can be noted from the underlines.

Construction Work

It is of course easily understood that an installation of this size entails considerable preliminary construction work. Without even attempting to enter the details of the work involved, let us skim over for a moment a few figures that will show conclusively the magnitude of the task. The main building in which this mill is located is approximately 500 feet long by 68 feet wide. The tables for the mill run the complete length of the building, and reinforced concrete foundations for all these tables, shear, etc., had to be laid. Then there were the foundations for the different power plant units. All this meant considerable work, for it was absolutely necessary to trench down until good solid ground was reached. The inserted panel tells its only story in this respect. The construction views depicted illustrate a little of the work entailed, but we are making no attempt to touch this work in detail. Enough to say that the foundations are laid 14 feet down underneath the mill and of course tunnels are provided to allow workmen to attend to bolting down, repairs, etc. The amount of concrete used is surprising. Over 10,000 cubic yards of solid concrete has been laid and over 1,000 bolts have been used, these ranging from 1½ inches diameter up to 3 inches. A very notable



THE PICTURE TO THE LEFT SHOWS THE DIGGING OF TRENCH FOR TABLES, WHILE THE OTHER VIEW IS THE PREPARATORY WORK ON FOUNDATIONS FOR PORTION OF ELECTRICAL EQUIPMENT.

performance in continuous concrete pouring was brought to our attention, and the quantity poured is well worth repeating. In 2½ days 1,153 cubic yards were poured, this of course being for 24-hour days.

Electrical Equipment

The mill is direct connected to a 5,000 h.p. reversing motor of the compensating commutating pole type, and is specially designed to withstand the severe service encountered on reversing rolling mill work of this nature. The speed range of the motor is 120-0-120 r.p.m., and since the speed is quite slow during a considerable portion of the time, and the momentary current peaks are high, it has been designed for forced ventilation. A Buffalo Forge Co. fan is used, this equipment being placed in a lean-to at the side of the power house.

There is also a flywheel motor generator set, this consisting of a 2,000 h.p. wound rotor induction motor driving a 50,000 pound cast steel flywheel, and a special d.c. generator. This generator is also of the compensated commutating pole type and is designed to withstand the same peak load as the reversing motor.

The exciter set is of 3 piece construction, consisting of a 7½ K.W. exciter, and a 25 K.W. constant potential generator driven by a 50 h.p. induction motor. The magnetic control, main switch board, and air washing outfit are all located in the same building as the motor generator set.

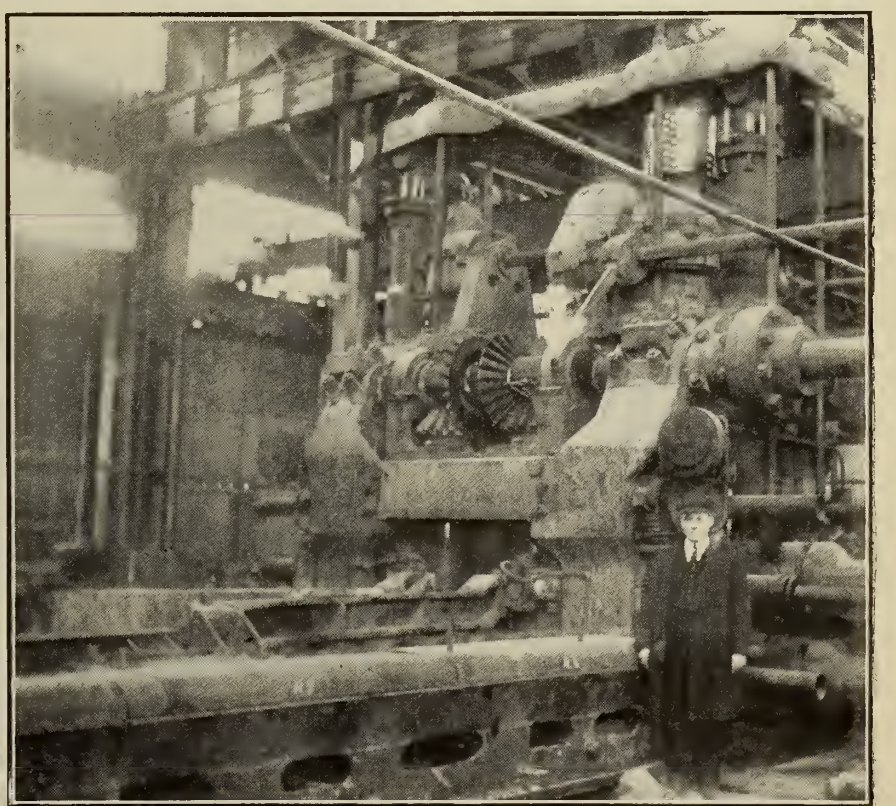
The switchboard and control apparatus is very interesting. The reversing motor is controlled automatically by magnetic switches. Adjustable relays control the rate of acceleration and retardation of the motor, so that it operates at a rate consistent with the reductions which are taken in the mill. The control is so interlocked that the motor always has full field when starting. Further increase in the speed, up to a maximum, takes place after the generator field has attained full strength.

The main switchboard controls the 2,000 h.p. A.C. motor, as well as the exciter and blower motors, and has mounted thereon the necessary meters for measuring the power of the different circuits. Two automatic oil circuit breakers are used between the power line and the primary of the 2,000 h.p. motor. One of these circuit breakers is for forward operation of the flywheel set, and the other breaker is for reversing the power to the set in order to make a quick stop when operating at full speed. This feature is included because it is sometimes desirable to bring the flywheel set to rest quickly, in case of trouble of any kind.

Between the D.C. generator and the reversing motor, an electrically operated high capacity automatic circuit breaker is used. The purpose of this circuit breaker is to interrupt the main D.C. circuit in case of very extreme overloads. The master switch is mounted in the operator's pulpit, and on an inclined panel in front of the operator is a D.C. ammeter and voltmeter for indicating the power transferred between the generator and reversing motor. This panel also has red and green lamps that indicate the position of the main circuit breaker.

The secondary of the 2,000 h.p. A.C. motor is controlled by means of an automatic liquid slip regulator. The position of the electrodes, and thus the amount of resistance inserted, is governed automatically by the torque motor, which in turn is actuated by means of a current transformer in the primary leads of the main motor. If the regulator is set for the average load on the motor during operation of the mill, it will take a constant input from the power circuit as long as the equipment is operating up to capacity. As peaks come on, the torque of the small motor is increased due to the greater current in the primary leads, which raises the movable electrodes inserting more resistance in the secondary. This allows the motor to slow down, and shifts the peak to the flywheel. After the peak has been taken care of, the input to the main motor will be maintained until the set is brought up to approximately full speed.

The excitation for both generator and motor is supplied by the small exciter



GENERAL VIEW OF THE PLATE MILL. F. C. WALKER, THE SUPERINTENDENT, IS A BIG MAN—BUT SMALL IN COMPARISON WITH THE MILL.

set. The direction of the roll motor excitation is not changed during operation, but is varied to meet the conditions of load and speed requirements. The operation is as follows: With the flywheel set at full speed, and master controller in "off" position, the roll motor will not be in operation, since the generator has no field current. The motor now has full field and the generator field is gradually excited, bringing up the voltage across the motor armature which will cause the same to revolve in the direction indicated by master switch. Compounding of the reversing motor is accomplished by means of the series exciter, which is excited by the current flowing between the generator and the motor. In this way any variation in the load on the mill motor will vary its total field excitation, thus giving the effect of a compound motor without the disadvantage of reversing such heavy currents in the series winding, which would be required in machines of the usual type. Due to this system, compounding can be varied to suit the operating conditions without the necessity of shunting heavy currents.

The speed at which the roll motor runs is practically proportional to the impressed voltage, independent of load up to full field on both motor and generator. From here, the speed is increased by manipulating the field of the motor. During the pass, the load on the generator is often very much in excess of the average over the entire cycle, and the automatic slip regulator enables the flywheel to supply the difference between the average input to the set and the load on the generator during the peaks. A slip regulator automatically inserts resistance in the secondary of the induction motor when its primary current reaches the average value, so that the speed of the set is reduced, allowing the flywheel to give up a portion of its energy. When the load on the generator decreases below the average for which the regular is set, this operation is reversed, i.e., the difference between output of induction motor and input required by generator goes to bring the set up to maximum speed. By this system, the input to the set may be limited to practically a constant value, independent of peak loads which are several times the maximum load on the line.

The roll motor is rapidly brought to rest by regenerative braking if the voltage on the generator is lowered below that corresponding to the speed of the motor. In pumping back power into the set, a large portion of the accelerating energy is reclaimed, helping each time to increase the speed of the set and consequently the energy stored in the flywheel. A device for accomplishing rapid acceleration is incorporated so that when it is desired to speed up the operation the normal time for building up the generator voltage can be reduced.

The incoming power is 13,000 volts, 3 phase, 27 cycle, and is brought through an underground cable 1,500 feet from the main substation of the company. It is transformed down to 2,200 volts immediately at the mill power house.

The power for screw down and table D.C. motors is furnished by a motor generator set consisting of a 400 K.W. generator 220 V.D.C. connected to a 590 h.p. synchronous motor 2,200 V, 3 phase, 25 cycle. This also furnishes the power for driving the D.C. motors on all tables, plate leveller, manipulator, furnace pusher, shear depressing table, punch rollers, etc. Provision is made for installing an additional motor generator set to duplicate this when required.

Various Details

The billet shear used is of Mackintosh & Hemphill design, and was built by the Canadian Allis-Chalmers Co. The capacity of the shear is 10 feet by 10 feet square, and slabs up to 40 inches width can be cut. The stroke is 12 inches, the length of knife 48 inches, and the number of strokes 14 per minute. It is driven by a 125 h.p. induction motor and the clutch shifter is worked by a 9 h.p. D.C. mill motor with brake and limit switch. The shear gauge is also of M. & H. design, and is operated by a 9 h.p. D.C. motor.

The shear depressing table, back of the shear, is 23 feet long with 11 rolls 14 inches by 48 inches. It is driven by a 60 h.p. D.C. mill motor at a speed of

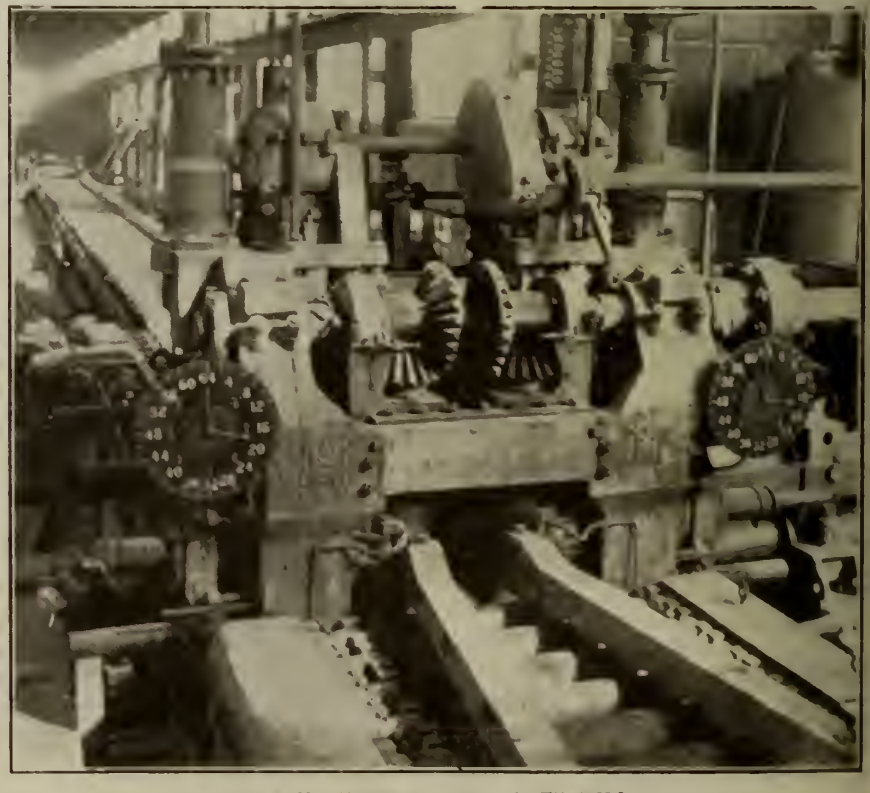
SOME VIBRATION

F. C. Walker, plate mill superintendent at the plant we are speaking of, tells a funny story about vibration. "You are, of course, well aware," he started off, "that a plate mill of any size is always subject to considerable vibration, but you have to actually experience the sensation before you have any conception as to its extent.

"When you stand on the pulpit, or as some might term it, the control bridge, you feel the sway to a nicety. I remember on one occasion the foundations were none of the best, and the vibration and swing was worse than usual. It was like standing on the bridge of a ship during a rather nice swell.

"On reaching home that night I could still feel the sway, but the limit came when I actually woke up in the night to find myself grabbing the bed post firmly in order to keep myself from falling off the pulpit."

The little tale about vibration may seem to the uninitiated as exaggerated, but when we consider that the firm installing this plate mill at Hamilton saw fit to have a 14-ft. deep foundation of reinforced concrete, there must be something to the story. Below the concrete again there is placed considerable piling to a still further depth of 30 ft., this, of course, being to prevent sinking. Good, firm soil must be reached before the foundation proper is poured. In the old days these were of stone, not concrete, but were never as satisfactory as the modern method. Before a foundation is commenced, the ground is carefully drilled to ascertain its quality at different depths. Having this information at hand, they can proceed to drive their piling.



CLOSE UP VIEW OF THE PLATE MILL.

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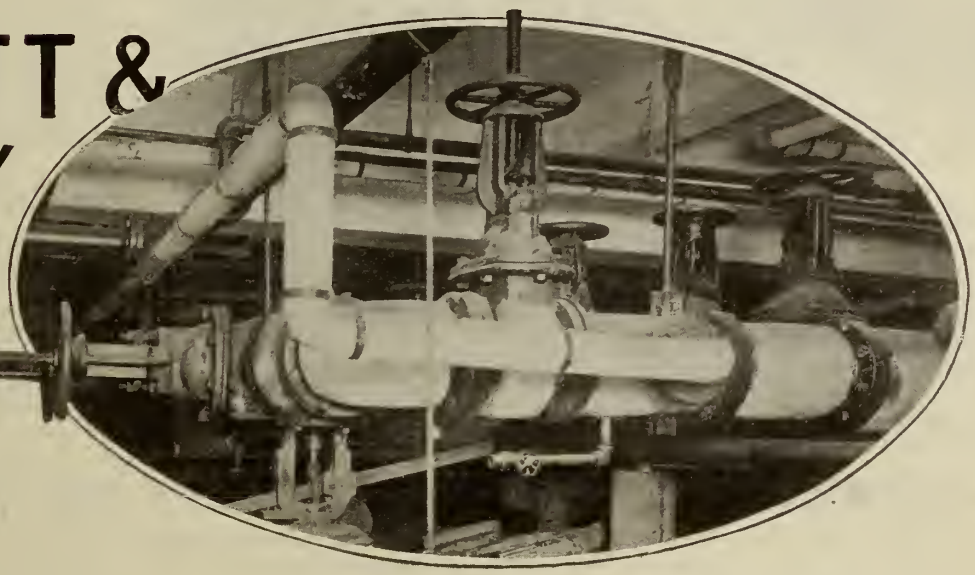

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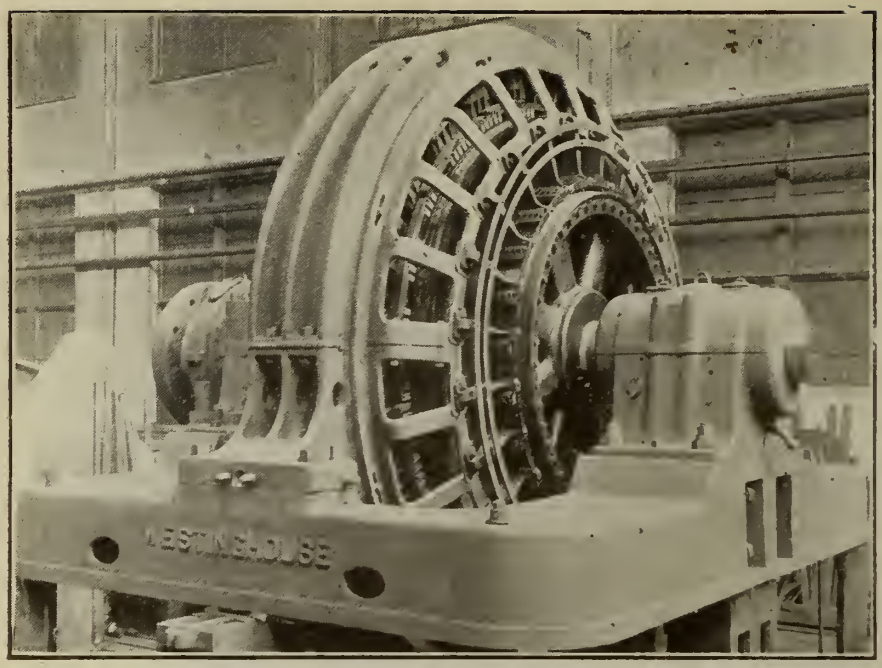

THIS ILLUSTRATES THE 5,000 H.P. REVERSING MOTOR WHICH DRIVES THE MILL.

266 feet per minute. The shear run out table is 45 feet long with 27 rolls 14 inches by 48 inches and is driven by a 60 h.p. D.C. mill motor running at a speed of 266 feet per minute.

The punch rollers are located immediately back of the shear run out table and are 18 inches by 48 inches. These rollers are for delivering skelp, etc., to the piler, the intention being to cut skelp sheet. bar, etc., on the billet shear without going over the hot bed. The speed of rolls is 480 feet per minute.

The shear equipment consists of a cut-off and two side shears with an arrangement of c stor beds to serve them. A 10-ton platform scale 5 feet wide and 50 feet long is also arranged for castors.

On account of the variety of products, a diversity of heating furnaces is necessary. A 32-foot continuous furnace with double electric charging pusher and delivery pusher places the ingot directly on to the approach table.

The mill tables, front and back, are 35 feet long, each having 20 rolls. The 13 rolls next to the mill are spaced 17 inches, while the balance are spaced 21 inches. All rolls are 14 inches diameter, 72 inches long. The maximum speed of table is 428 feet per minute. The case, and the table beams are made of cast steel and the roll bevel gears, as well as the drive gears, are machine cut cast steel, running enclosed in oil.

Each mill table is driven by two 80 h.p. mill reversing motors, connected in series. These motors have full magnetic plugging control, and are so arranged that the motors on the incoming table work at half speed, while the outgoing table works at full speed in either direction.

The two controllers are mechanically connected, and the operator uses only one handle to operate all four motors. This is accomplished on the first point of the master controller in either direction, and on the second point both tables run at full speed.

The approach table is driven by a 60 h.p. motor. The length of this table is 70 feet and it has 35 rolls spaced 18 inches centers in front of furnaces; while the balance are spaced at 21 inches and 30 inches centers, the latter distance being at the extreme end of table. The speed of this table is 350 feet per minute. There is also an extension to the table, this being 55 feet long, but with no rollers.

The run out and hot bed tables are each 145 feet long, the former having 58 rolls and the latter 61. These rolls are 14 inches diameter, 59 inches long and the center distance between the rolls is 30 inches. As on the other tables, the gears have machine cut teeth and run in oil. The speed of the rolls is 350 feet per minute. Each of these tables is driven by two 60 h.p. mill type motors connected in series.

A plate leveller is situated between the run out and hot bed tables, and this is a nine roll machine made by R. S. Newbold. The rolls are 10 inches diameter, 72 inches long and their speed is 158 feet per minute. Motor drive and screw down are of course provided. Extended shoe plates are provided to allow for removing leveller and inserting a dead roll when rolling slabs or billets.

A second continuous double skid furnace is installed alongside the first furnace, and is equipped with a hydraulic pusher. This will handle larger bloom. and ingots up to 50 feet and the pusher will deliver material directly to the table. The capacity of both these furnaces is about 4,000 to 6,000 tons respectively.

It is the intention ultimately to make provision for four soaking pits, two to be installed later, but the first pits are four hole 6 feet by 9 feet with hydraulic operated covers. These pits are arranged for oil firing with provision for producer gas later. The soaking pit building is located immediately adjoining the furnace building, with the approach table through center, having two pits on each side.

The buildings in which these units are housed are of steel construction and provision is made for extending shipping room as required. The main building extends across the other buildings and is partitioned off from the power house

PARTIAL VIEW OF TABLES AND MILL. NOTE—THE AUTOMATIC SWITCHES ARE IN THE GLASS-PROTECTED BUILDING TO THE LEFT OF THE TABLES.

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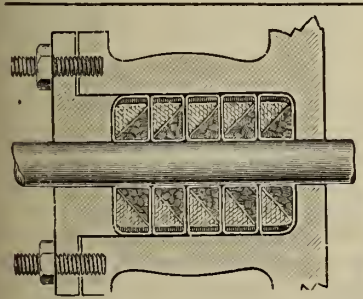

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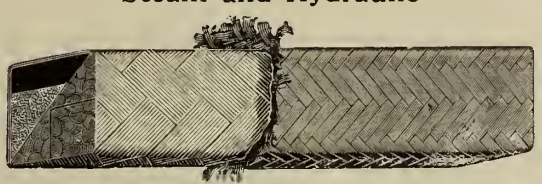

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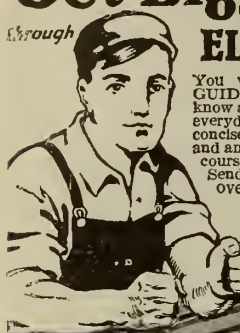

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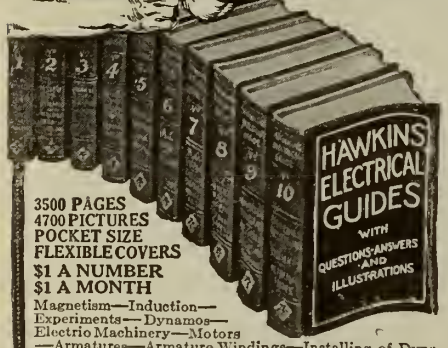

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An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

READER'S NOTICE

Regarding

CHANGE OF ADDRESS

A REQUEST FOR CHANGE OF ADDRESS must reach us at least thirty days before the date of the issue with which it is to take effect. Duplicate copies cannot be sent to replace those undelivered through failure to send this advance notice. Be sure to give your old address as well as the new one.

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

The power house walls are reinforced concrete and glass with gypsum slab roof and concrete floor. The mill building and power house are served by a 40-ton crane, while other cranes in the plant are of 10-ton capacity.

With the exception of the mill and plate leveller, all the tables, shear pushers, punch roller, and accessory machinery was built in Canada. No doubt readers will remember our Jan. 8th issue in which we told of the work being done for this mill by the Dominion Steel Products Co., Brantford, Canada. The steel castings for the work performed in Canada were supplied by the Dominion Foundries & Steel, Ltd., from their own foundry.

The idea of producing as much as possible in Canada is to be commended, and here is how the work was distributed. The tables, including shear depressing and furnace pushers was made by the Dominion Steel Products, Brantford, Ontario, the shears by Canadian Allis-Chalmers, Toronto; manipulators by John Inglis, Toronto; buildings by Hamilton Bridge Works, Hamilton, Ont.; while the electrical equipment was supplied by the Canadian Westinghouse Co., Hamilton, and the Canadian General Electric Co., Peterboro, Ont.

A good feature of this installation is the railroad facilities provided. Three railway tracks serve the billet yard, shipping department and mill building, while a track runs right into the building at one point.

Briefly stated, the addition of this mill should mean much to Canadian business generally. Billets and blooms from 3 inches by 3 inches to 8 inches by 8 inches, slabs from 2 inches to 8 inches thick and from 6 inches to 40 inches wide are now available, while skelp of all sizes and weights 8 inches and wider can be made. Sheet bar (for sheets) of all sizes and weights can be produced, and universal plate from 7 inches to 41 inches of any thickness and length can be made. In addition to this list, sheared plate 66 inches wide, and of any thickness can be procured. The capacity of the mill being 150,000 tons per year will allow them to handle the demand easily. In fact, when in full swing this installation will be one of the largest steel finishing units in Canada.

Want Guarantee.—The National Shipbuilding Company, of Goderich, which was organized in 1917 to build trawlers to the order of the British Admiralty for use in the North Sea, are asking the town council of Goderich to guarantee a bond issue that has been created on the property and assets of the company. The organization is perfecting and manufacturing a flax-pulling machine of the Vessot model, on which the patent rights are held both in Canada and abroad. Marine engines and boilers were made for the Imperial Munitions Board, the French government and the United States Emergency Fleet Corporation. Before the shipbuilding industry began to subside, the National Shipbuilding Co. turned its attention to the manufacture of the flax-pulling machine. In asking the municipality to guarantee the bond issue, the company points to its record including wage payments aggregating $400,000 for three years and nine months ending December, 1920.

REGULATING OVERFLOW IN HYDRO

Continued from Page 38

by the water in the penstocks. When the gates are opened enough so that the penstock can be filled in 5 minutes, the limit switch opens and stops the motor and another limit switch prevents over travel. The gate is closed by reversing the control switch at the power house and a limit switch again stops the motor when the gate reaches its closed position.

In order to facilitate handling or to save head room in gate houses, sluice gates may be built in detachable sections, in which case cranes or hoisting winches are used to handle the gates. When a failure of the turbine governors will result in dangerous over speeding it may be desirable to have the head gates close automatically. This may be done electrically with a centrifugal switch. Tripping ropes from the head gates may also be arranged so that an operator can trip any head gates from the power house, the gate closing by gravity.

When gates are remotely controlled the gate opening can be shown with suitable signal lamps.

At one plant in Canada two timber flap gates are used to close each half opening of the entrance to a penstock. These gates differ somewhat from the ordinary, as they are hinged at the bottom and are provided with concrete counterweights at the top, which keep them open under normal conditions. They swing in a manner similar to a wagon box end gate, and when open they rest on a concrete sill at an angle of about 45 degrees from vertical, so that hoisting can be done easily. As all parts of these gates are submerged below the point of freezing they make very good gates for a cold climate.

Steel gates are also built in this way and at one plant the power house crane handles them.

Two sources of power for handling gates which have not been mentioned are gasoline engines and small water wheels. At one place I know of a gasoline engine is used to operate the gates at the intake of a long flume, while at another place gates are handled with a 25-h.p. water wheel, clutches being provided to connect the gate to a long shaft, which is driven by the wheel.

A new industry has opened a factory at Selkirk, Man., and is known as the Canadian Insulation Company. The head office is in Winnipeg.

TRADE GOSSIP

Brantford Firm Changes.—The Brantford Machine & Tool Co., Ltd., has just been incorporated to continue and add to the former business of the Brantford Machine & Tool Co. Mr. Wm. J. Ham, a son of Mr. Jos. Ham, of Ham Brothers, has taken an interest in the concern and will take an active part therein. In addition to their old line of machine and machine tool work, they intend extending and manufacturing a line of garage equipment, such as bench presses, boring tools and small air compressors, and expect to find quite a ready market for same.

A large British factory, which was erected during the war chiefly for the production of "dope" or varnish for aeroplane purposes, is turning its attention to the application of these and other products as peace time products. It has been found that this aeroplane dope makes an excellent insulating varnish for electrical machinery. Further, paper strips drawn through the solution become impregnated with it and are then suitable for winding on copper wires to make "paper-insulated" cables for telephone and electric power purposes. Artificial silk, which can be braided on to wires instead of the natural silk, is also produced; and still another possible line of development is in the molding of electrical connections in celluloid, which has a very high electrical resistance and is non-inflammable even when exposed to the heat of a fierce flame. All these products are "synthetic"; that is to say, they are built up by chemical processes from simple constituents.

NEW CATALOGUE

The Ross Heater & Mfg. Co., Inc., Buffalo, N.Y.—Catalogue F, dealing with the Ross heater. This heater is of the closed or tubular type. They are used for heating all kinds of fluids and the customary heating medium is steam. The common liquid heated is water, but oil, sugar juice, chemical compounds, or any other liquid can be heated. There are two types of heaters, instantaneous and storage. Various photographs, specifications and sectional views are given in this catalogue.

The Hanna Engineering Works, Chicago, Ill.—Catalogue No. 3. A very complete catalogue dealing with compression yoke riveters; 48 pages are filled with real, live information, showing details of construction, specifications and completed riveters of various types. This concern have also sent us a book of instructions that should be in the hands of anyone operating one of their riveters. It is full of practical and valuable hints that should save any trouble in operating, not to speak of obtaining maximum production. They also have a catalogue No. 10 that deals with their line of foundry moulding machines in splendid detail.

Terrell's Equipment Co., Grand Rapids, Mich.—A catalogue describing their line of steel cupboards, wardrobes, lockers, shelving and bench drawers. Different arrangements are shown and all dimensions of the various sections are stated.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	29 50
1¾-in.	29 75	27 00
2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
3½-in.	63 50	43 50
4 -in.	85 00	55 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$5 25	$5 25
Plates, ¼-in. up	4 75	4 75

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger, net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.00

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15
Standard	0 15 to 0 40
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15
Carriage bolts, 7/16 and up	Net
Coach and lag screws	20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	5
Machine bolts, ⅜-in. and less	30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 27½
Solder, guaranteed	29½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$32 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	34 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	40 00	42 00
Copper sheet, planished, 16-oz. base	46 00	48 00
Braziers', in sheets, 6 x 4 base	38 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13
X L C R	14½		

Colored

Lion	13½	Popular	10
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10½
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$39 00	$40 0
Spelter	7 75	7 5
Lead	5 75	7 5
Antimony	8 00	8 2
Aluminum	34 50	30 0

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 5
Sheets, 3½ lbs. sq. ft.	10 25	14 0
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 5

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Jones "A-C"

High-Duty Stoker

Labor Saving
+Coal Saving
-Maintenance
=Actual Economy

An Important Deduction

Never forget upkeep—that all-important deduction—in choosing a high-duty mechanical stoker. Only real—not theoretical saving—makes a stoker installation pay dividends.

The big yearly saving of the Jones "A-C" Stoker is practically *net,* for it is not cut into excessively by maintenance costs.

The Jones is the simplest of high-duty multiple retort stokers. The one moving part within the furnace—the pusher rod—is buried deep in the green fuel where there is no possibility of it burning out. There are no moving or wearing parts in contact with hot coal. And all wearing parts are heavily built of materials that insure long life.

The simple, driving mechanism eliminates the use of driving shafts, bearings, gear boxes, gear shift devices, hand shift clutches, chains, levers, shearing pins, etc.,—complications that always mean high maintenance, if not frequent shut-downs.

Retorts and tuyeres are so constructed and placed that the under side is fully exposed to the air in the air pit, and consequently properly cooled. The entire bottom sides and end of each hollow tuyere block are exposed to the air so that burned-out tuyere blocks are uncommon.

Is it at all surprising that the repair cost in a representative "A-C" equipped plant averaged *only one cent per ton of coal* burned?

Because of this extremely low maintenance, the unchallenged ability of the Jones "A-C" Stoker to effect still greater economies in burning Canadian coals, makes it the logical choice for Canadian plants of every size.

Where shall we send your copy of the new catalog?

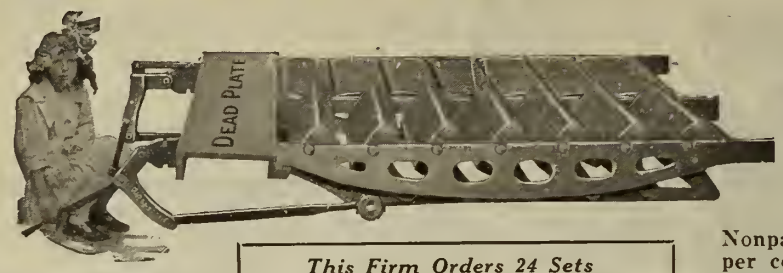
The Under-Feed Stoker Co. of Canada
LIMITED

81 Victoria Street, Toronto

The Canadian Stoker

JONES Stokers are made in Canada by Canadians and sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized—and the reorganization makes available, for Canadian power users, the extensive engineering resources of the Under-Feed Stoker Co., of America.

Pays For Itself-Then Pays Dividends



NONPAREIL
Shaking and Dumping
GRATES

AGENTS WANTED
Good opportunities for engineers. Write now to

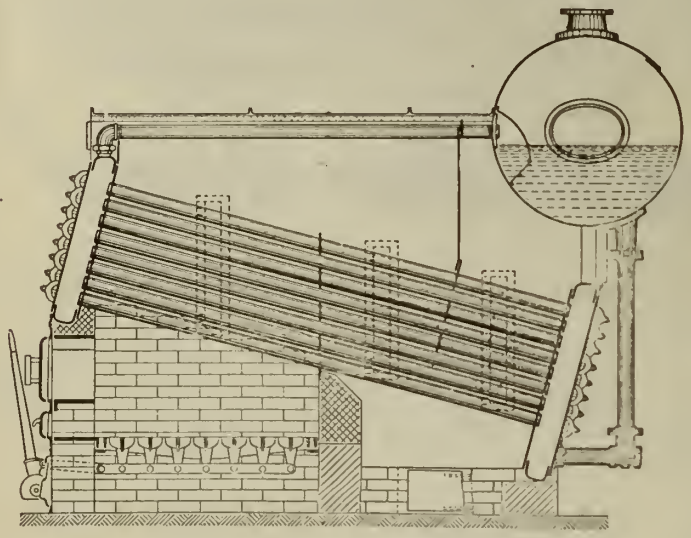
This Firm Orders 24 Sets
Phippen & Field, one of Toronto's largest Brick manufacturers, have recently ordered 24 sets of Nonpareil Grates for their new brick kilns—a wise move considering the price of fuel.

Nonpareil Grates are guaranteed to save at least 10 per cent. of your present coal bill. Introduce this economy into your plant.

Write us to-day for particulars.

THE W. R. SEXTON BOILER SETTING COMPANY 127 D'Arcy Street. 'Phone Coll. 682
114 Grenadier Road. 'Phone Jct. 2765W

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N.S.

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New and Used Power Plant Equipment

PETRIE

Quality and Service

Whether the power plant equipment you purchase from Petrie be new or used, you are assured of two things:

That the quality of the equipment is dependable. We handle only lines of recognized merit.

And that your order will receive the prompt courteous attention of an efficient staff.

Let us send you full particulars of any power plant equipment in which you are interested.

H. W. Petrie, Limited
Toronto and Hamilton

How to Solve Your Bearing Problems

The cheapest and most reliable form of insurance against interrupted production from worn out bearings is to have on hand in your own shops several bars—in sizes to meet your needs—of

MUELLER
BRONZE BEARING METAL

These bars contain high percentages of copper and tin, giving a tough, close-grained casting to stand high speeds and heavy pressure. We carry a full assortment of Mueller Solid Bars from ½ in. O. D. to 4 in. O. D. in lengths of 12 ins.; in Mueller Cored Bars all sizes from 1 in. O. D. x ½ in. I. D. to 4 in. O. D. x 2¼ in. I. D.; all in lengths of 12 ins. Complete list of sizes and prices will be furnished on request. Mail orders given prompt attention.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.

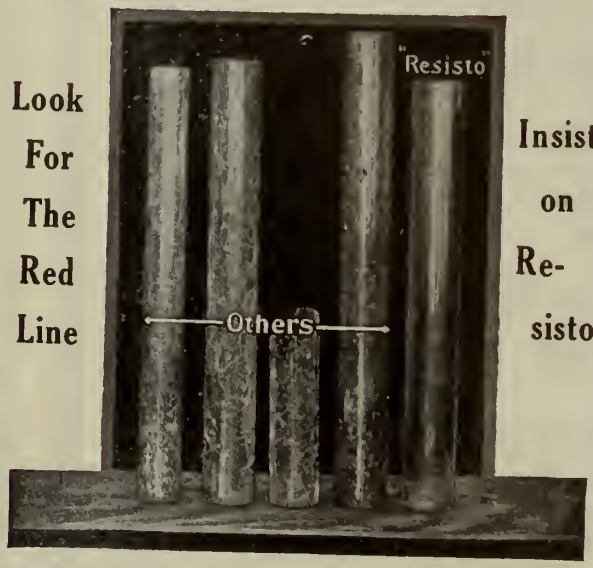
You can again obtain Genuine "Resisto" Gauge Glasses with the Red Line—

You'll be glad to know this. No more dangerous experimenting with inferior glasses. You can depend upon the "Resisto"---its reputation is your assurance of perfect service.

Get your order in at once.

Note below the result of a very severe test in which the "Resisto" was tested with several well-known brands of glasses.

THE SCHAEFFER & BUDENBERG MFG. CO. RESISTO HIGH PRESSURE GAUGE GLASS



Look For The Red Line

Insist on Re-sisto

THE
SCHAEFFER & BUDENBERG MFG. CO.

338 Berry St.

BROOKLYN, N.Y.

Toronto—A. G. Milton, 32 Front St. West

400 pages of text and illustrations in permanent binding of green vellum

Temperature Efficiency

Indicating, Recording, Controlling

A book that should have a place in every industrial library. Authoritative. 1,000 illustrations. Compiled by engineers. Serves also as catalogue for Tycos Temperature instruments.

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There's a Tycos or Taylor Temperature Instrument for every purpose

Which Way for You-

25c. for a new seat ring or disc---
Or $2.50 for a complete new valve?

About 99% of valve wear comes on the seat ring of a gate valve and on the disc of a globe valve. Looking that fact in the face, doesn't it strike you as absurd and wasteful to have to throw away an entire valve merely because one small part of it has worn out?

Pratt & Cady Renewable Valves eliminate this big waste.

If a leak develops, you simply take out the worn seat ring or disc and slip in a new one. The whole operation takes only a jiffy. You don't even have to remove the valve from the line—which makes a considerable saving in labor cost on top of the other saving.

This gives you a good-as-new valve at approximately one-tenth the cost of a new old-style valve. Write for catalog.

PRATT & CADY, INC.

Manufacturers of Valves and Asbestos Packed Cocks that give long and satisfactory service.

Factory: Hartford, Conn., U.S.A.

The Canadian Fairbanks-Morse Co., Limited

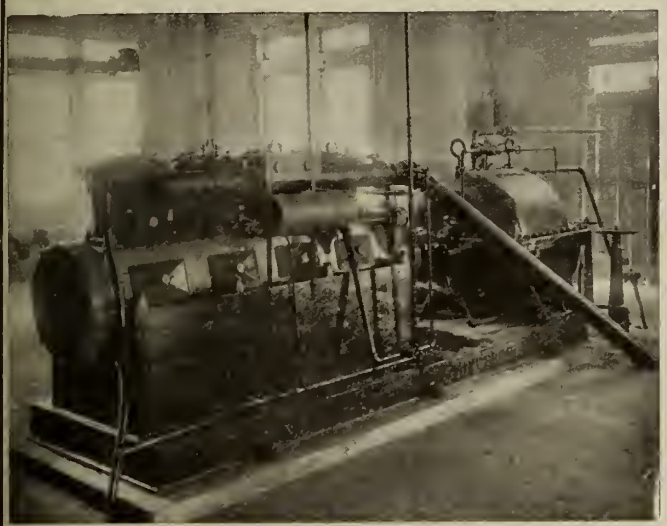
Halifax	Montreal	Windsor	Calgary
Sa. John	Ottawa	Winnipeg	Vancouver
Quebec	Hamilton	Saskatoon	Victoria

PRATT & CADY
RENEWABLE VALVES

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Look where you will—there is no cheaper nor more efficient prime mover than a high duty gasoline engine when correctly built.

We build them of the finest materials at a price of $19 per H.P., for continuous emergency duty, at speeds up to 1500 R.P.M.—same as centrifugal pumps or electric generators.



Interior City Pump House, St. Johns, Que., Model FC 8-cyl., 200 H.P. Sterling, direct connected to Kingsford 2-stage Turbine Fire Pump; Suction 12-in.; Dischorge 10-in.. total head 235 ft., speed 1400 r.p.m., employed as standby unit for emergency.

Catalog on Request.

STERLING ENGINE CO., Dept. C-4, BUFFALO, N.Y.

12 to 300 H.P. Speeds 400 to 1500 R.P.M.

Improve the Efficiency of Labor Cut Down Coal Consumption

Now is the time to improve the all round efficiency of your plant by relieving your men of the tedious drudgery incidental to hand feed water regulation, or the constant watching, adjusting and other attentions required by ordinary regulators.

Give your men a chance to use their hands and brains to cut down coal consumption by inspecting, testing, and studying the results of present operation and then making improvements that make for greater economy and increased efficiency.

The regulation of the feed water can be done much more scientifically, economically and reliably by

COPES
BOILER FEED REGULATORS

Our Bulletin D tells how this is done. Write for it.

Northern Equipment Co.
112 West 11th Street
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The World's Largest Manufacturers of Feed Water Regulators

Canadian Representatives:
ALLEN GENERAL SUPPLIES, LTD., 205 Yonge Street, Toronto, Ont.
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MASON REGULATOR & ENGINEERING CO., LTD., 153 Dagenais St., (St. Henry), Montreal, P.Q.
C. C. MOORE & COMPANY, Engineers, 618 Mutual Life Bldg., Seattle, Wash. (Representatives in British Columbia).
W. W. HICKS & CO., 567 Banning St., Winnipeg, Canada.
Canadian Factory: 191 Barton Street East, Hamilton, Ont.

Ten hours! More than a day's labor! Think of the cost in dollars!

Such was the result of a test between the flexible type of hack saw and an all-hard blade.

Both were designed to cut the same material! Both were carefully run to deliver the utmost service, but the all-hard blade demonstrated from the start that it cut costs by cutting quicker. On power sawing, where weight is needed to make the teeth of a blade "bite" into the stock, the soft-back saw is not practical. Because of its flexibility, pressure makes it "buckle" Without this weight the cost per cut is too high.

For economical power sawing the proper blade for the particular kind of material to be cut is indicated by the Starrett Hacksaw Chart. It will be mailed to you, free.

THE L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS.

Use Starrett Hack Saws

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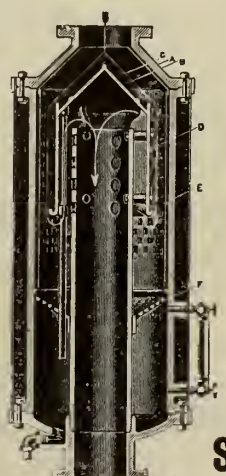
III IMPORTANT THINGS
TO CONSIDER ABOUT A SEPARATOR



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

A Stirring Instalment of Heming's Famous Story

ARTHUR HEMING continues his remarkable story of Canada's Northland in March 1 MACLEAN'S MAGAZINE. In "Wild Animals and Men" he tells how he and Oo-Koo-hoo tracked and trapped wolverine, lynx, and other wild animals, and tells fascinating stories of battles of wits between the hunters and the hunted. The wiles of the Indians and half-breeds are pitted against the amazing, almost superhuman craftiness of the animals—and sometimes the denizens of the forest wilds outwit their human antagonists.

Fun at Opening of Parliament

J. K. Munro sat in his seat in the Press Gallery, Monday, February 14, when Parliament opened, and looked down with the good-natured tolerance and contempt of an iconoclast and a satirist at the proceedings. The members invariably amuse "J. K."; it takes a really big man to elicit more than scant praise from his sophisticated pen. His March 1 article is entitled: "Funny, as the Owl is Funny."

Other Big Features and Fiction

"Canada's Fur Future," by Agnes C. Laut. Telling what a potential gold mine Canada has in her fur industry, properly conserved and exploited.

"Goldwin Smith," by James Mavor, Ph.D. The personal side of the "Sage of the Grange," the man who was tutor to King Edward VII, before coming to Canada.

"More Political Memoirs," by Col. George H. Ham. Further stories of the "Solons of the Eighties," and Ottawa 30 or 40 years ago.

"Pawned," by Frank L. Packard. The story of a triple regeneration—in this instalment John Bruce declares his love for the "Pawnshop Girl."

"The Man Who Knew Too Much: The Bottomless Well," by Gilbert K. Chesterton. This Near-Eastern well and a revolving bookcase figure in a baffling murder story, handled by England's master of fiction.

"The Lady at His Door," by Barker Shelton. A girl takes a law course, graduates—but that doesn't mean clients. But she gets a partner—and for life.

"The Millionth Chance," by Henry Holt. An Adventurous sea story, with a girl skipper and a man who won her respect—and even her love.

Review of Reviews

Split Among the Socialists— Joseph Gollomb

New Wonder City— Agnes C. Laut

Where Humanity Started— New York "Times"

World's Worst Failure?— Harold Trowbridge Pulsifer

Birth Control and War— Harold C. Cox

A Pugilistic Apollo— Heywood Broun

MARCH 1st ISSUE on All News-stands 20c

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"CANADA'S NATIONAL MAGAZINE"

We make Boilers—all Types—Plate Work—Pulp Mill Machinery, etc.

Have Faith in Canada

Canadians are a nation of workers—

We have the cream of the world's natural resources—

We have to-day the largest per capita purchasing power of any nation in the world—

We have to-day the largest per capita savings funds of any country in the world—

Normal efficiency of Canadian labor is being rapidly restored—

Canadian production per farm compares favorably with any other country in the world—

Exhaustion of stocks amongst retailers and wholesalers is everywhere apparent.

Available funds for business enterprises are accumulating in millions.

Will you do your bit to put the needed new life into business?

BUY WHAT YOU NEED—NOW

Engineering & Machine Works of Canada, Limited

St. Catharines, Ontario

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal

A Plain Question

What is the Canadian National Newspapers and Periodicals Association?

And a Frank Answer

For many years prior to December, 1919, all the publications in Canada practically were grouped in one Association, known as the Canadian Press Association. In this Association there were three sections, Daily, Weekly, and Trade and Class. A little over a year ago it was mutually agreed by the publishers comprising these three groups that more effective work could be done for and by each section if separate organizations were formed, and, coincident with that decision, there came into being the

Canadian National Newspapers and Periodicals Association

In this Association there are incorporated the following classes of publications:

Agricultural newspapers
Business newspapers
Educational newspapers
Religious newspapers
Technical newspapers and Magazines.

Membership in the Association involves certain obligations. Every paper admitted has subscribed to ten rigid Standards of Practice, the purpose of which is to afford ample protection to both the subscriber and the advertiser. Every publisher pledges himself, before he is permitted to enjoy the benefits of membership, to

"Consider first the interests of the subscriber," to

"Work for truth and honesty in all departments," and, among other things, to

"Supply advertisers with full information regarding character and extent of circulation."

These are only a few of the conditions which have to be subscribed to precedent to admission to the Association, but they will give an idea of the high standard demanded.

There are already embraced in the membership of this Association a very large majority of the reputable and responsible publishers of the newspapers and magazines classed above, and it is believed that within a very short time, practically all that are eligible—all who can conscientiously endorse the Standards of Practice — will have been enrolled in our membership.

List of Members

The publications listed below—all of them members of the Canadian National Newspapers and Periodicals Association —should be given preferential consideration in the planning of an advertising campaign. They embrace mediums which appeal to the consumer (either city or farm dweller), merchant, business executive, purchasing agent, technical man, etc. The combined purchasing power of the readers of these papers is greater than that of the total of all other classes of publications in Canada. The facilities of the office of this Association are at the disposal of any firm planning an advertising campaign. We may be able to give you information that will make your advertising dollar buy better value.

AGRICULTURAL NEWSPAPERS
Canadian Countryman
Canadian Poultry Review
Farmers' Advocate & Home Journal
Farmers' Advocate & Home Magazine
Farm and Home
Farmers' Magazine
Grain Growers' Guide
Maritime Farmer and Co-operative Dairyman
Nor'West Farmer
Weekly Witness and Canadian Homestead

BUSINESS NEWSPAPERS
Bookseller & Stationer
Business Review & Maritime Retailer
Canada Lumberman & Woodworker
Canadian Finance
Canadian Furniture World
Canadian Grocer
Canadian Hardware Journal
Canadian Insurance
Canadian Music Trades Journal
Canadian Woodworker & Furniture Manufacturer
The Commercial
Contract Record & Engineering Review
Dry Goods Review
Druggists' Weekly
Footwear in Canada
Financial Post
Hardware & Metal
Le Prix Courant
Marketing
Maritime Merchant
Men's Wear Review
Monetary Times
Motoring
Printer & Publisher
Phonograph Journal of Canada
Retail Grocer & Provisioner
Retail Druggist
Western Canada Coal Review
Western Canada Contractor
Western Lumberman

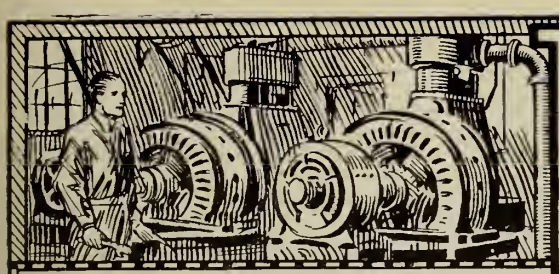
RELIGIOUS AND EDUCATIONAL NEWSPAPERS
Canadian Churchman
Catholic Record
Christian Guardian
East & West
Northern Messenger
Pathfinder
Pioneer
Presbyterian Witness
The School
Teacher's Monthly

TECHNICAL NEWSPAPERS
Canadian Engineer
Canadian Foundryman
Canadian Machinery
Canadian Manufacturer
Canadian Railway & Marine World
Electrical Dealer & Contractor
Electrical News
Marine Engineering
Municipal World
POWER HOUSE
Sanitary Engineer

MAGAZINES
Canadian Forestry Magazine
Everywoman's World
La Canadienne
MacLean's Magazine
Needlecraft Companion
Western Home Monthly
Woman's Century
World Wide

Canadian National Newspapers and Periodicals Association

Office - 70 Lombard Street - Toronto, Canada



MINISTRY of MUNITIONS

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The
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Factory Stores
Machine Tools
Railway Material
Electrical Instruments and Machinery
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Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
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Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

Constant Watchfulness

The Hays Automatic CO₂ and Draft Recorder maintains a constant watch over all the conditions which effect furnace efficiency, keeping a positive record of performance upon which improvements in practice may be based.

This automatic record helps the fire room force to attain the highest efficiency and hold it. It makes good results a continuous matter, which is more important than spasmodic changes. Firemen like it, for improved methods mean better results with less work.

Complete description of the advantages to be gained in your plant will be sent upon request.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances

1060 E. 8th St., Michigan City, Ind.

Represented in Canada by

Arthur S. Leitch Co.,
1001-2 Kent Bldg., Toronto

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ARE YOU WASTING MONEY?

You are if you use that class of packings that fade away almost at fast as you apply them.
REASON:—They are made of a low grade of short fibre asbestos, requiring cotton to hold them together, thus limiting the packing power to resist heat.
You can secure the full money value from your packing if you use

TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

as it is made strictly of long fibre asbestos of the first grade and thoroughly lubricated.

USE THE BEST PACKING AND YOU ARE NOT CONSTANTLY REPACKING THE STUFFING BOXES.

If you don't know the great lasting qualities of "Palmetto" let us send you a free working sample—it will convince you.

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Sole Manufacturers 109 Duane St., New York

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CRANE
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HEAD OFFICE & WORKS
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MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
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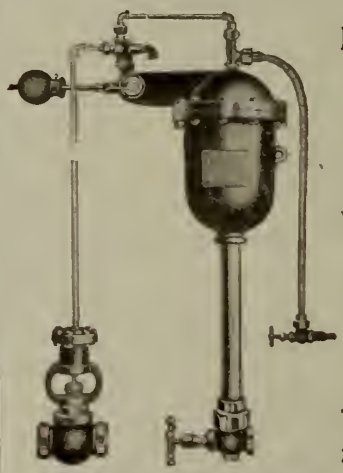

Insure Constant Level

The most economic way to operate boilers is with constant water level and uniform constant inflow. With the level held constant at middle gage, the greatest amount of heating surface is presented to the hot gases and the maximum amount of steam space is available.

Vigilant Feed Water Regulators

meet these conditions in a very satisfactory way.

They are easily adjusted to maintain an absolutely constant water level at any arbitrarily determined height in boilers, and they feed continuously with perfect uniformity.

Write for full particulars

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes

Trial Orders Solicited—Our Packings Do the Rest

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED
LONDON LIVERPOOL CARDIFF, ETC.

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Wm. J. Brown, 117 Youville Square, Montreal
Stocks Carried in All Sizes TEL. No. MAIN 2387

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
26 Craig Street - MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E. S. MANNY Co
27 COTE St MONTREAL, QUE

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System

Largest manufacturers of white metals in the world

Solder
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DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
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Lead Traps
and Bends

HOYT METAL COMPANY
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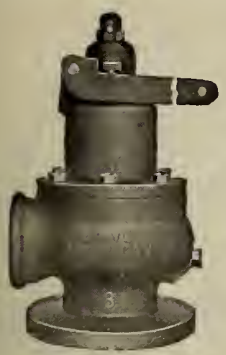


Model E
For Saturated Steam

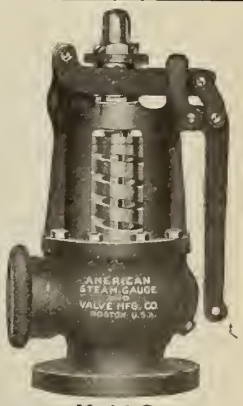
American Pop Safety Valves

Simple in Design
Few Working Parts
Selected Materials

All combine to bring about real safety where
AMERICAN POP SAFETY VALVES
are installed.

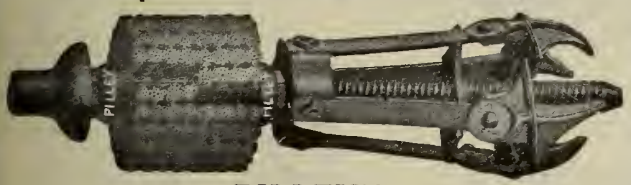
Economy follows naturally where these Valves are used.

American Steam Gauge & Valve Mfg. Company
New York Chicago Boston Atlanta Pittsburgh



Model G
For Superheat

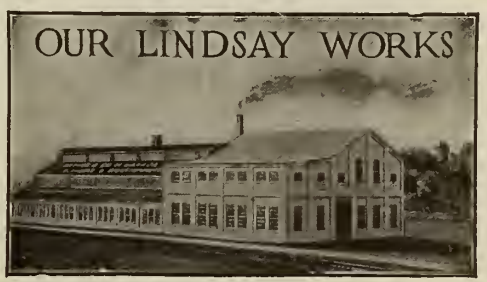
The Simplest and best cleaner on the market is



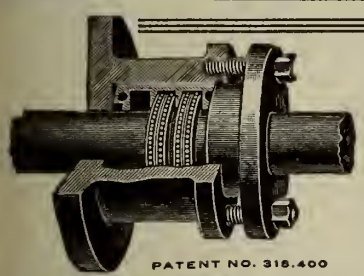
PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario



PATENT NO. 318,400

PAT. NO. 500,899
" " 534,104
" " 602,626
" " 654,541
" " 654,542
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" " 774,490
" " 775,193
" " 775,194
" " 791,300
" " 805,669

PAT. NO. 829,116
" " 830,530
" " 856,103
" " 876,235
" " 894,537
" " 895,791
" " 898,068
" " 905,108
" " 934,629
" " 979,206
" " 1000,75

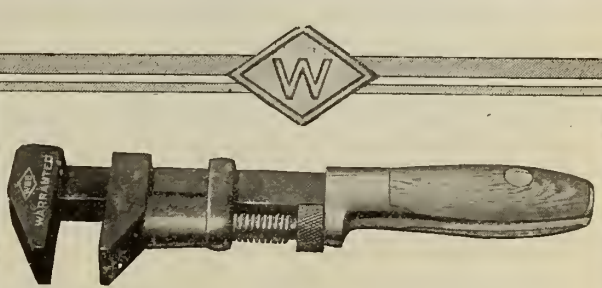
Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.



A Wrench that IS a Wrench

No better wrench than the "W & B" Machinists' Knife Handle is made. With its head and bar drop-forged in one piece, its extra heavy jaw case hardened and its screw turned from solid steel, it possesses the quality that distinguishes all of Williams' Superior Machinists' Tools—absolute dependability. It will do the job it was built for, do it well, and keep on doing it indefinitely.

Sizes 6 to 21 inches carried in stock.
2 other patterns also. Ask for booklet.

J. H. WILLIAMS & CO.

LIMITED
"The Wrench People"

Formerly Canadian Branch of
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78 Thorold Road St. Catharines, Ontario

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.
Why not get acquainted through a trial order? Ask for our catalogue.

JOHN MONCRIEFF, Ltd., Perth, Scotland

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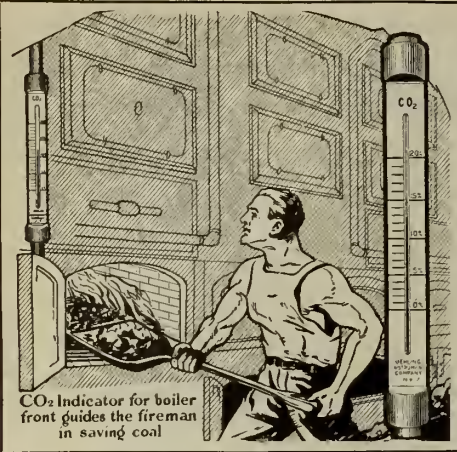


CO_2 Indicator for boiler front guides the fireman in saving coal

The Big Boiler Room Waste

is the heat discharged up the chimney

UEHLING CO_2 EQUIPMENT

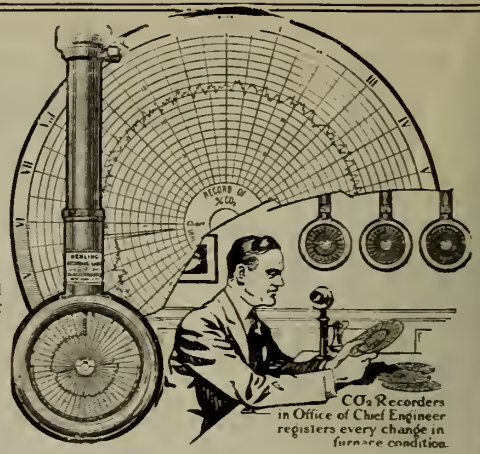
keeps tabs continuously (not intermittently) on this waste, thus enabling engineer and firemen to co-operate in reducing it. Uehling CO2 Equipment is simple in principle and operation and uses no chemical solutions.

Write for New Catalog.

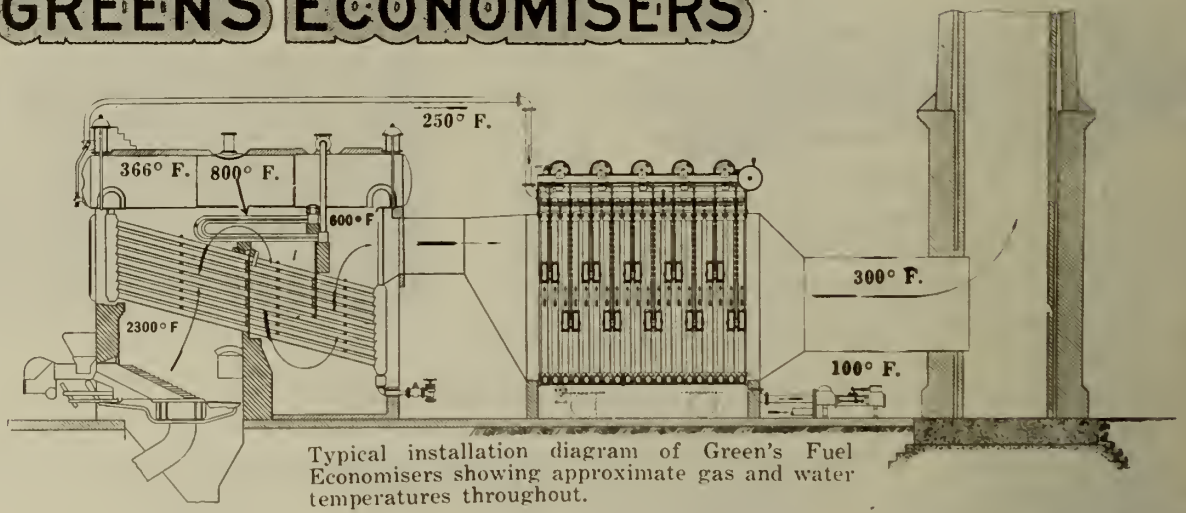
UEHLING INSTRUMENT CO.

Combustion Engineers

2008 Empire Bldg. - New York


CO_2 Recorders in Office of Chief Engineer registers every change in furnace condition.

GREEN'S ECONOMISERS



Typical installation diagram of Green's Fuel Economisers showing approximate gas and water temperatures throughout.

At the recent Chemical Exposition in New York, during the fuel economy conference, one of the speakers, a noted engineer, stated that by far the greatest heat loss in the boiler room was in the sensible heat of the exit gases.

The use of extra boiler surface to cool gases below 500° F. does not pay because below 500° F. the heat absorbed per square foot of heating surface does not equal the cost of maintenance. The use of **Green's Economiser** is the **most economical method** for recovering this loss—it will reduce the gas temperature to a low figure at minimum cost—by transferring the heat of the gases to the feed water, under boiler pressure, thus allowing the boiler to be supplied with water at a temperature slightly lower than the steam itself.

Write for our bulletin No. 151, or call for one of our engineers to inspect and make recommendations for your conditions.

GREEN'S ECONOMISER, LIMITED. TORONTO

Money-Saving Information

"The most useful information contained in any paper I get"—so a Western banker writes in to-day's mail, renewing his subscription for FINANCIAL POST.

"Very often," his letter goes on to say, "I am called on to suggest investments for small amounts, sometimes as low as a few hundreds, and I find your Investors' Inquiry Service a reliable partner to consult. If every investor knew there was such service at his call it would surely lessen the losses of many of these people."

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It costs FINANCIAL POST subscribers nothing to be sure before placing hard-earned savings in stocks that may never have a chance of paying dividends. Trained service men will give you the benefit of keen analysis based on the facts behind the securities you are considering. This is one of many features enjoyed by our readers.

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Send me for one year (52 issues) The Financial Post. I attached $5.00—commence at once.

Mr. Engineer, are you—

one of those wide-awake, up-to-the-minute engineers who is willing to be shown how economies can be effected in the boiler room? Many power plants in Canada and the United States, especially noted for high operating efficiency, consider "Bailey" meters essential to the best operation of either coal or oil-fired furnaces.

Bailey Boiler Meters

"Bailey" Boiler Meters — the coal savers—record the true relation between the coal and air supply to the furnace and plainly show the men what adjustments to either are required to maintain high operating efficiency and economy.

CHARTS SHOW PERFORMANCE OF INDIVIDUAL BOILERS

and tell when a boiler requires cleaning or inspection for leaky tubes or broken baffles. You can check the work of the fireman at all times.

Try one "Bailey" Boiler Meter and you will soon order "Bailey" equipment for all of your boilers.

May we send full details? Tell us your requirements.

COAL SAVERS

Bailey Meter Co.
2001 E. 46th St.
CLEVELAND, OHIO

UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube
(*Patented U.S. and Canada*)
Return Tubular
Locomotive
Upright

We specialize in the making of

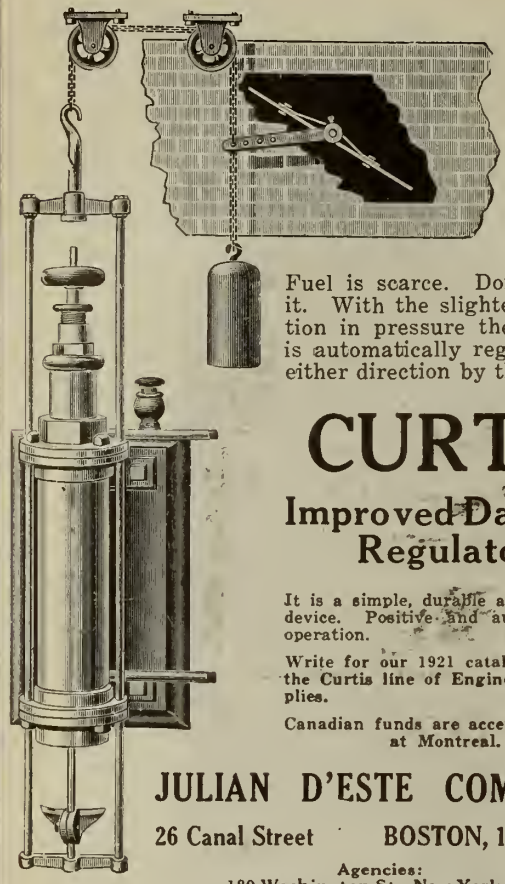
Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

Head Office and Works: LONDON, CANADA

86th Year

Branches and Agents from Coast to Coast

LEONARD



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

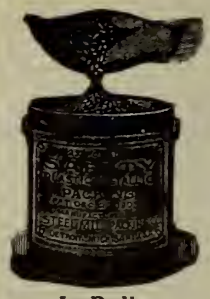
Write for our 1921 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

26 Canal Street BOSTON, 14, MASS.

Agencies:
180 Washington St., New York City
174 North Market Street, Chicago, Ill.



In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.
Drop us a line and let us tell you all about this remarkable packing and our "Safety" Superheat Sheet Packing.

In Cotton Tubes

STEEL MILL PACKING CO., WINDSOR, ONT.

SPECIAL NOTICE TO SUBSCRIBERS

We have received some complaints from subscribers to the effect that "Power House" is not being delivered. In almost every case investigation has shown that our friends have changed their addresses and have NOT notified us.

Let every subscriber look at the address on the label on this issue of "Power House," and if it is not correct, please fill in and mail to us the following—

Name .....

Old Address .....

Change to

New Address .....

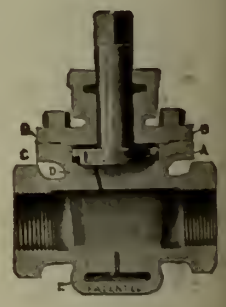
Occupation .....

Address : "Power House"
143 University Ave. Toronto, Ont.

You Lose No Time When You Use

HOMESTEAD
QUARTER-TURN VALVES

It takes from eight to ten turns of the wheel to open or close the ordinary globe or gate valve, while a Homestead requires but **one quarter turn!** Think of the convenience, think of the time saved on any service where frequent opening and closing is required.



That's why HOMESTEAD'S have replaced globes and gates in hundreds of plants.

They are used for air, steam, water, oil, or acids, and will keep your pipe lines absolutely tight.

HOMESTEAD VALVES are made in Straightway, Threeway and Fourway patterns.

Write for catalogue.

HOMESTEAD VALVE MFG. CO.

HOMESTEAD, PA.

Worthington satisfies every power plant pumping need

IMMENSE shop facilities, standardized manufacturing plus over 81 years of designing, improving and manufacturing pumps and pumping machinery have resulted in apparatus of suitable design for every power plant pumping duty.

This broad range and varied choice of apparatus together with over 200,000,000 boiler horse power successfully satisfied since 1840 justifies specifying Worthington for power plant apparatus. The Worthington engineering corps always stand ready to co-operate in order to obtain greatest possible results from apparatus selected.

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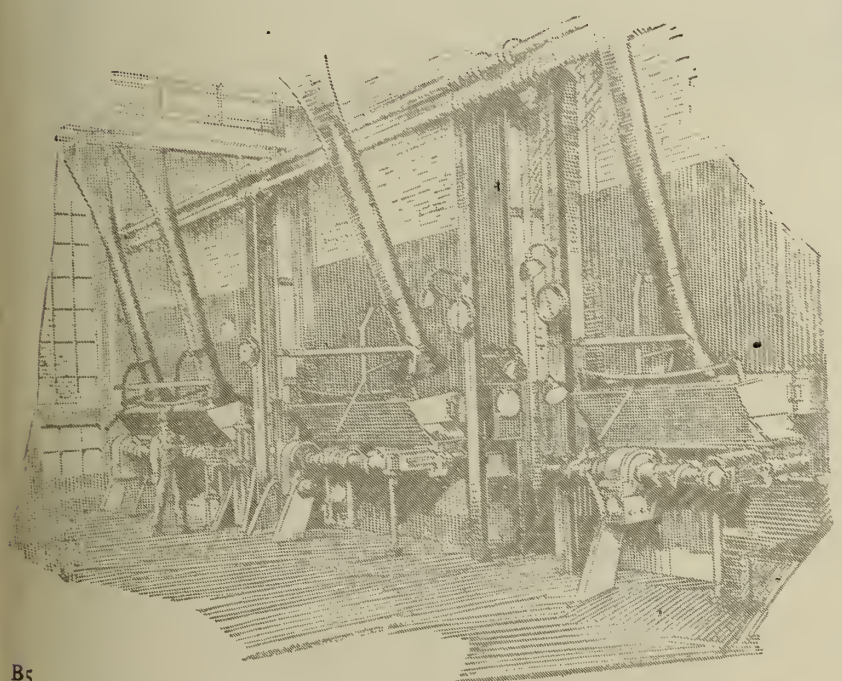

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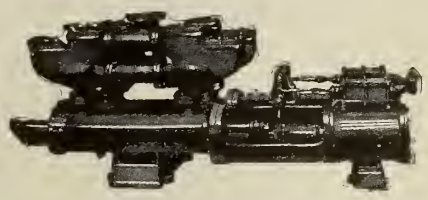
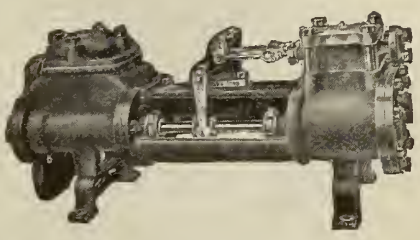
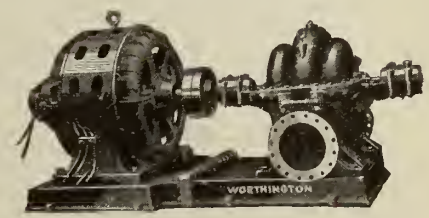


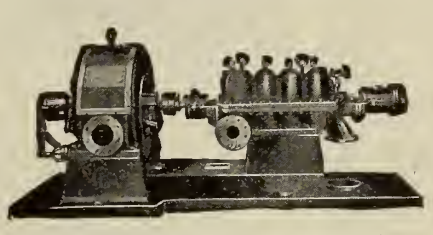
Pot Valve Boiler Feed Pump



Duplex Packed Piston Pump



Split Casing Double Suction Volute Pump



Worthington Double Suction Centrifugal Boiler Feed Pump

Centrifugal pumps often become steam bound while handling hot water. Under such conditions the rotating element of the average pump may seize at close clearance points. Worthington double suction centrifugal boiler feeder is equipped with a special floating sealing ring device which prevents this binding.

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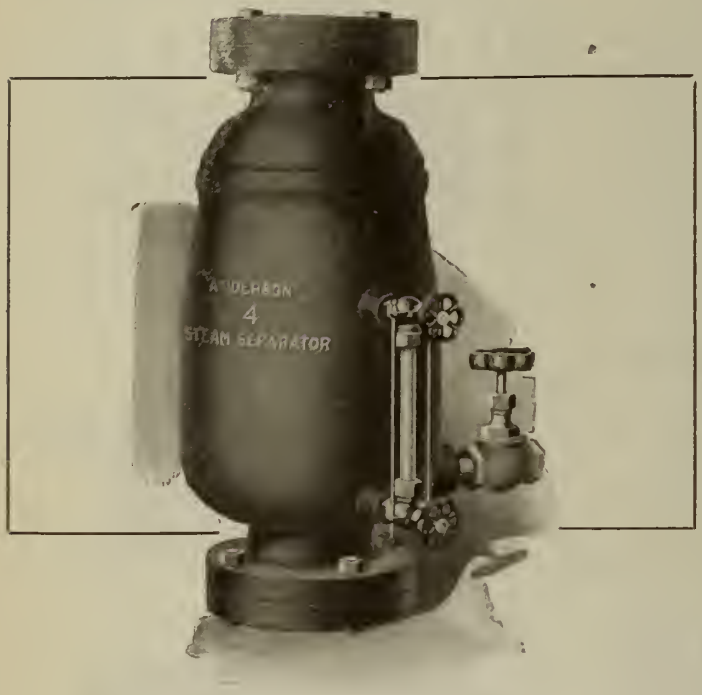
ANDERSON
Steam Separator



An Insurance Policy

You take out an Insurance Policy to safeguard and provide in case of accident. You use an Anderson Steam Separator to safeguard and prevent accidents from occurring. Yet there's quite a similarity, for an Anderson Steam Separator is a positive insurance against engine breakdowns due to accumulated moisture in engine cylinders and turbine casings.

The Anderson delivers **dry steam** under all operating conditions. Its improved construction places it in the foreground for efficient operation.

A copy of catalog fully describing all Anderson Power Plant Specialties will be forwarded on request.

The V. D. Anderson Co.
1935 W. 96th St. - Cleveland, Ohio

Diamond Soot Blowers Mean Greater Profits

THE big central stations place a definite re liance upon Diamond Soot Blowers to ear dividends. They know that to pay real pro fits they must cut the cost of producing power t a minimum. Their very existence, as a matter o fact, depends upon efficient, economical plan operation.

With perfect unanimity of action the big centra stations have adopted as one of the fundamenta principles of efficient boiler operation the rul that all boiler heating surface must be kept fre of soot and ash deposits, clean as only Diamon Soot Blowers can make them.

The illustration at the top of this pag shows one of many Diamond installations at th Union Electric Light and Power Company's S Louis plants. Among hundreds of other centr station users of Diamonds the following a typical:

Buffalo General Electric
Beech Bottom Power
Detroit Edison
Appalachian Power
Philadelphia Electric
Southern Power
Scranton Electric
Erie Lighting
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Central Illinois Public Service

Whether you operate a central station or industrial power plant your 1921 profits will seriously affected if you do not keep your boile in first class, efficient condition. Diamond Soot Blowers will increase your dividends out of proportion to the cost of the equipment.

Write for Bulletin 280

DIAMOND SPECIALTY COMPANY
WINDSOR, ONTARIO

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

REGISTERED
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COPPUS TURBO BLOWERS EFFECT STEADY SAVINGS

In the modern plant of the New York Ice Company, New York City, this 22" COPPUS Turbo Blower has been saving time, money and labor ever since installation in April, 1917. It has **made possible** the use of cheap fuel, and **made sure** the maintenance of constant steam pressure. So satisfactory has been the service of this COPPUS Blower that two more blowers have since been purchased for other plants of the New York Ice Company.

COPPUS Turbo Blowers are cutting down fuel costs and keeping up steam pressures in cold storage and artificial ice plants all over the country. Automatically regulated, self-oiling, quiet-running—COPPUS Turbo Blowers are by far the most efficient means of securing mechanical draft.

Let our engineers tell you just what COPPUS Blowers can save you in your boiler room. Write for Blower Catalog

"COPPUS" Equipment can "Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

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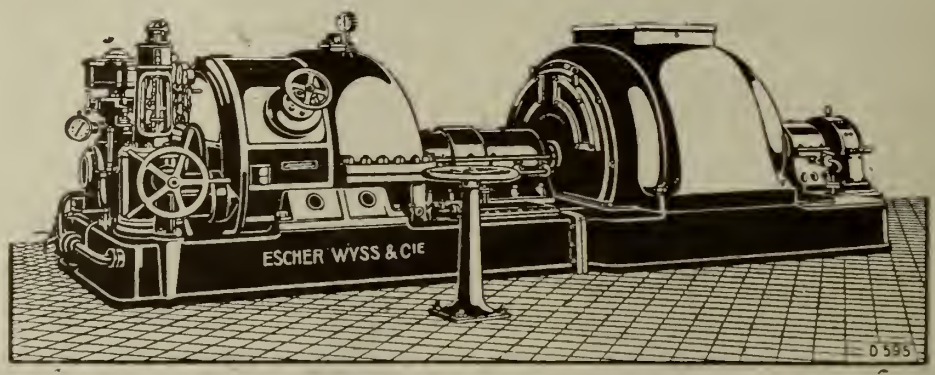
Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

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114 Liberty Street - - - New York, N. Y.

Two Steel Buildings For Sale., *in Stock*

Consisting of:

ENGINE HOUSE: 113 ft. by 55 ft., having 10-ton Crane Runway entire length.

BOILER HOUSE: 125 ft. by 60 ft., having six 100-ton bunkers, which can be purchased separately if desired.

Buildings were designed for snow-load in the Canadian North-West, and are now located on the Pacific coast. Erection and detail drawings are available, and buildings are offered at very attractive price.

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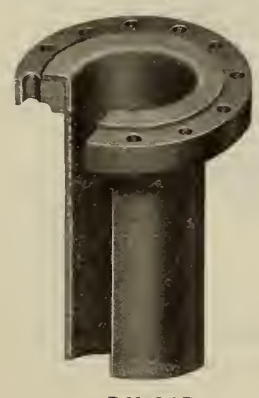
P H FLANGED PIPE JOINTS

SCREWED



P.H. LAP

P H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

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Superlative Silk and Vulcan Soot Cleaners

Cheney Brothers, manufacturers of the famous Cheney Cravats, known the world over for their superlative quality, use Vulcan Soot Cleaners in their Manchester, Conn., plant.

So, also, do many other of America's leading manufacturers who, because they produce goods of high quality, demand plant equipment of equal quality.

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES

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This Big Southern Company Uses 14

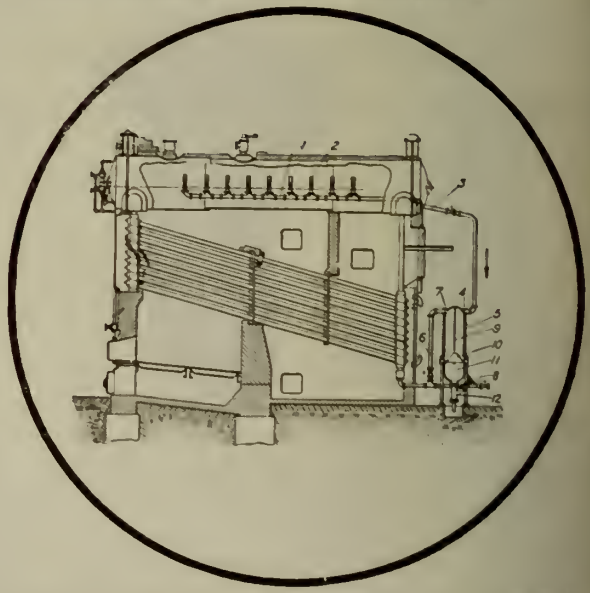
The Union Seed and Fertilizer Company, which operates a great many plants throughout the South, has installed 14 YARWAY BOILER SKIMMERS. Their initial order was for one Skimmer on sixty days' trial; now they order them in lots of three and four. The illustration shows a skimmer operating in their Columbia, S. C. plant.

The YARWAY BOILER SKIMMER prevents the formation of scale by automatically and continuously removing impurities from the boiler feedwater. What it has done for this well-known concern, it can in all probability do for you, if you are having trouble with scale in your boilers. It will surely pay you to investigate, at least.

YARWAY

Boiler Skimmer

(A Continuous Circulating Surface Blow)



Description—Temperature difference between water in boiler and wate[r] circulation pipe 3 and settling chamber 5 causes constant circulatio[n] direction of arrows. Scum and foreign matter are constantly drawn fr[om] boiler and in passing slowly through settling chamber 5 sink to bottom [of] chamber 11, whence sediment is blown out through blow-off valve 12.

Drop us a postal for a copy of Bulletin S-1201-A, which tells the whole story.

YARNALL-WARING COMPANY

7604-20 Queen Street
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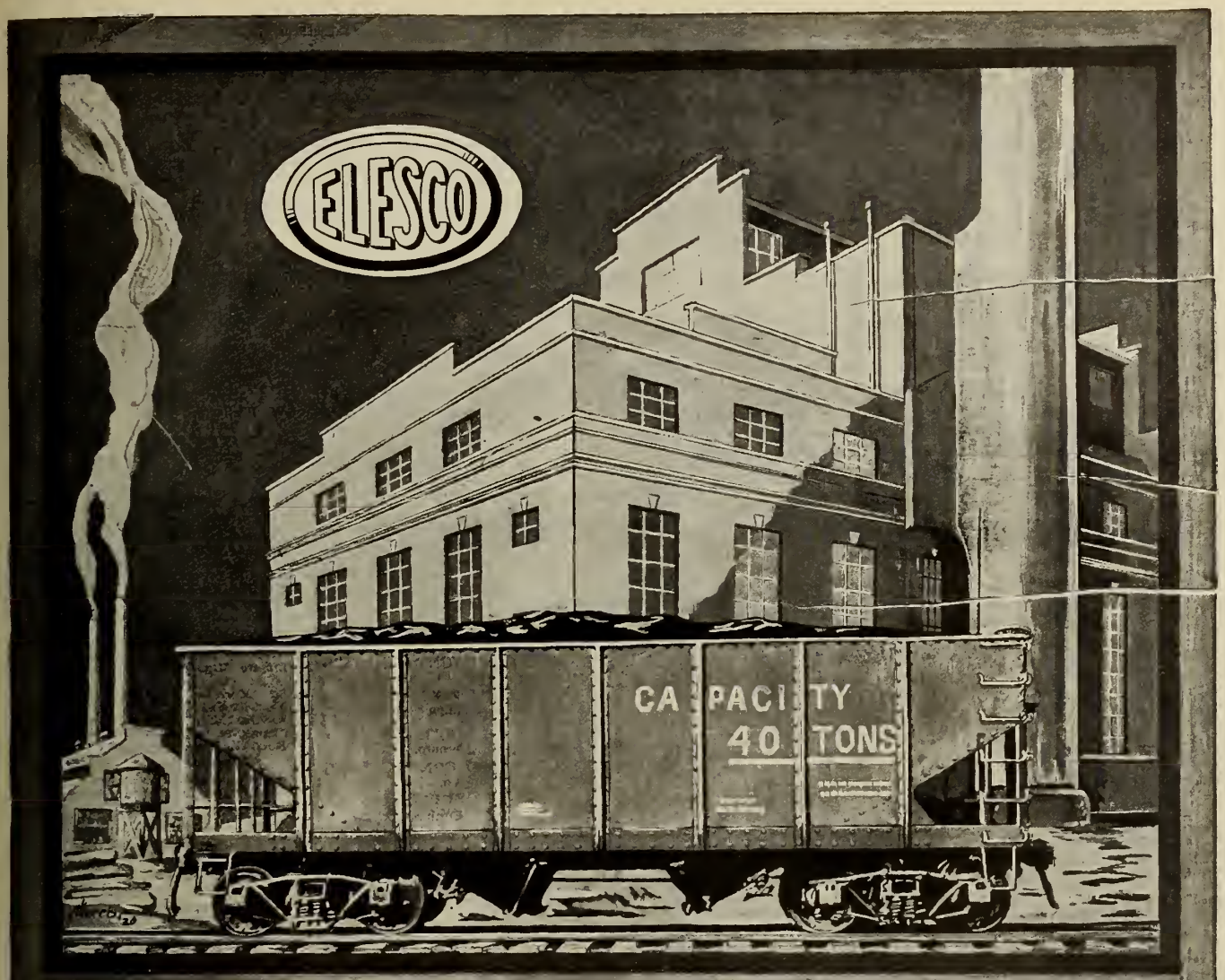
Offices in all principal cities



1921 MARCH 1921

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EVERY 7 DAYS A CARLOAD SAVED

ELESCO superheaters save fuel—In large plants a saving of 10 per cent. may be reasonably expected.

In a plant operating 24 hours a day, under a load of 5000 K.W., 2100 tons or 50 carloads of coal are saved a year by superheating. A carload is saved every 7 days.

In smaller plants, savings as high as 20 per cent. are disclosed. May we show you how the installation cost is quickly wiped out by the saving in fuel?

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TRANSPORTATION BLDG., MONTREAL
WORKS AT SHERBROOKE, QUEBEC

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for All Purposes.

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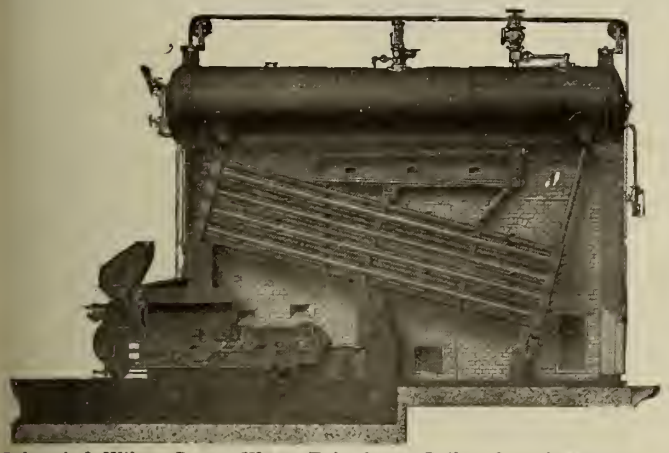

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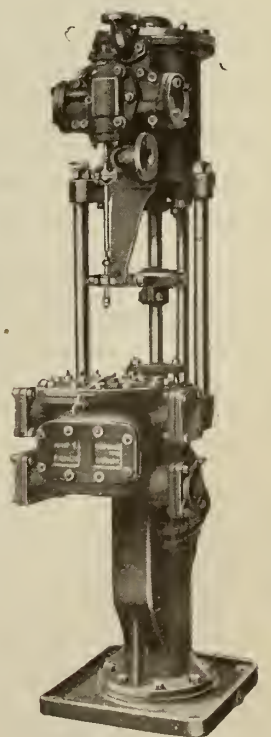

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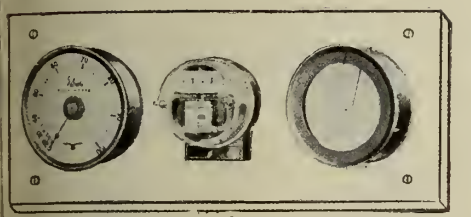

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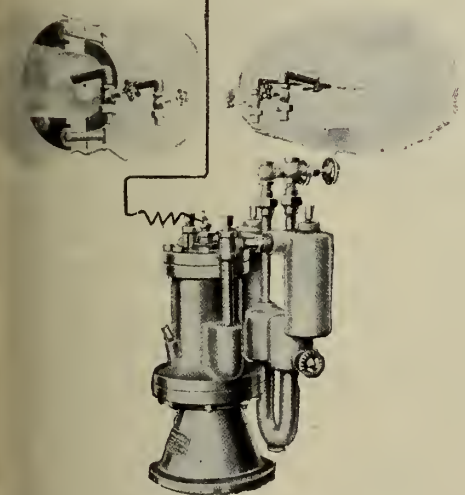

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Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co. Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos W Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal
Can. Steam Boiler Equipment Co., Toronto
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto
Mason Regulator & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATOR
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk Con.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto
D. K. MacLaren, Ltd., Montreal, Que.

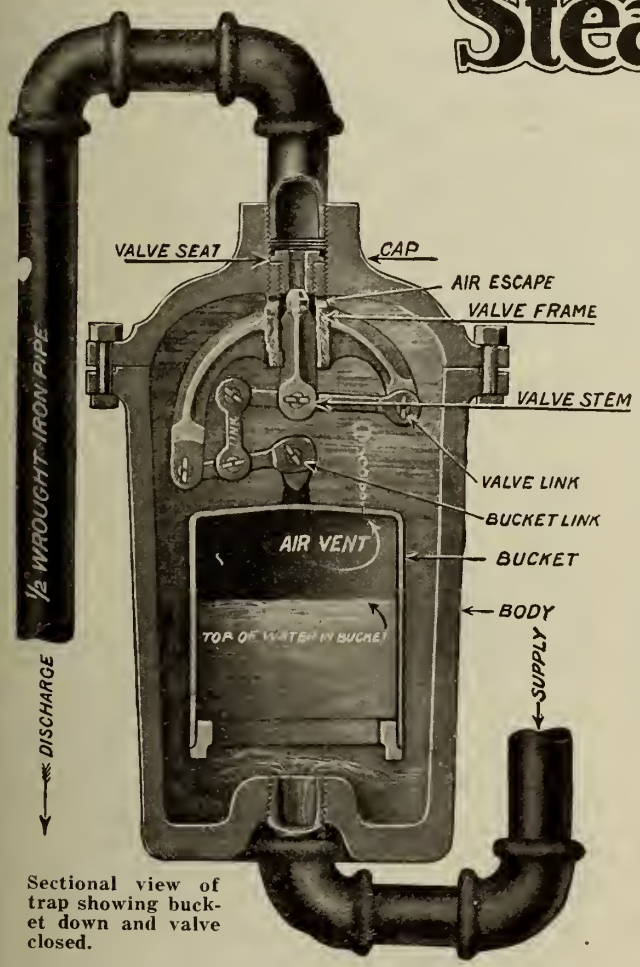
LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada

Armstrong Steam Trap



Sectional view of trap showing bucket down and valve closed.

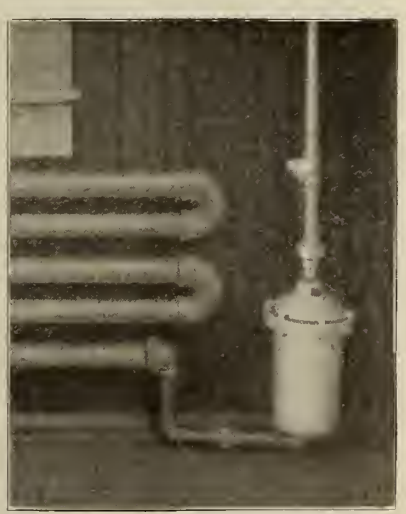
The Best Trap to Handle Condensation— Its Principle is Different

THE exclusive "Inverted Submerged Bucket" feature of the Armstrong Steam Trap mark it pre-eminently as the **best** trap to handle your condensation.

It absolutely will not pass steam. It will not become air-bound and is least affected by sediment, scale or oil. It requires a minimum of attention and upkeep; is compact, easily installed, and is of ample capacity for the work. Furthermore, it is an economical investment, cost, capacity and upkeep considered.

THE Armstrong Trap is small in size and light in weight compared with the ordinary trap. It is easily connected and may be suspended on a pipe line; neither foundations nor pits are required. This and the fact that an Armstrong is self cleaning and operates with little attention, is the reason for its widespread popularity with big power plants.

Write for details of our guarantee and 60-day offer.



A No. 2 Armstrong Trap draining a low pressure coil in Fairbanks-Morse & Co.'s plant. Note the water seal at the trap. Holes in the floor are unnecessary as Armstrong Traps need not be set below the coil.

THE ARTHUR S. LEITCH COMPANY
LIMITED

1001-2 KENT BUILDING, TORONTO, ONT.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

PACKING, ENGINE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Beldam Asbestos (Canada) Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Beldam Asbestos (Canada) Co., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester
Pratt & Cady, Hartford, Conn.

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American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

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American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. Steam Boiler Equipt. Co., Toronto
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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S. F. Bowser Co., Ltd., Toronto, Ont.

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American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

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Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

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American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton

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American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

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American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
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Escher, Wyss & Co., Montreal, Que.
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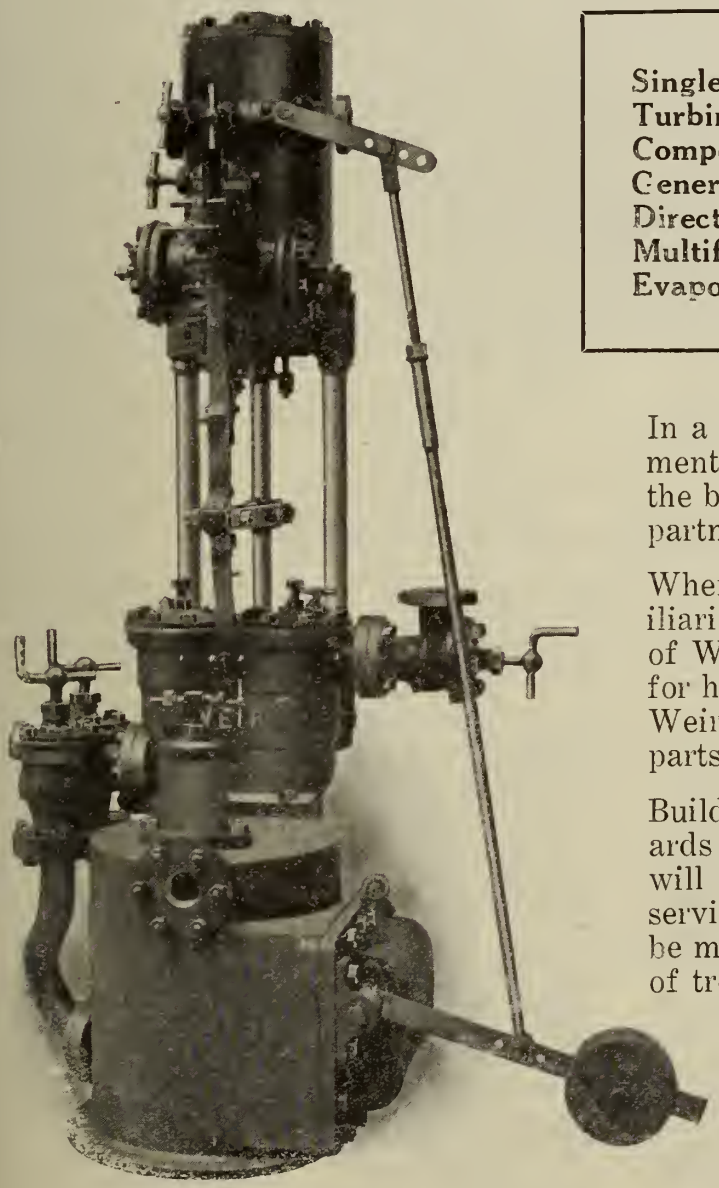

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
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Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Yarnall-Waring Co., Phiadelpbia, Pa.

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Darling Bros., Ltd., Montreal, Que.
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Uehling Instrument Co., New York, N.Y.

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Sarco Co., Inc., New York, N.Y.

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Penberthy Injector Co., Windsor, Ont.

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Vilter Mfg. Co., Milwaukee, Wis.
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Penberthy Injector Co., Windsor, Ont.
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Watson & McDaniel Co., Philadelphia.

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Toronto.

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Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

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Mason Reg. & Eng Co., Ltd., Montreal.
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Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
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Boving Hydr. & Eng. Co., Ltd., Lindsay.
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Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
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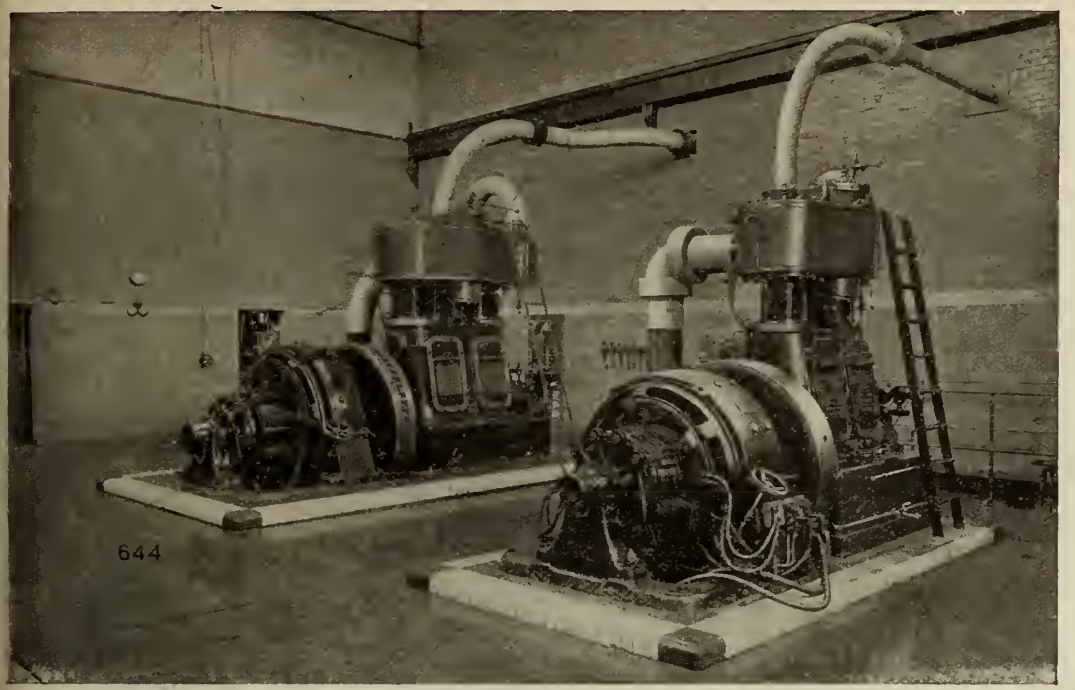

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Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

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Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
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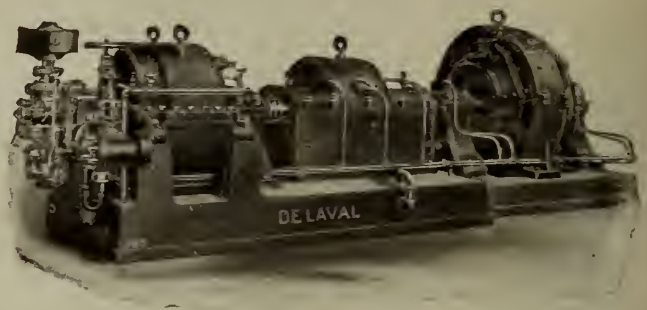

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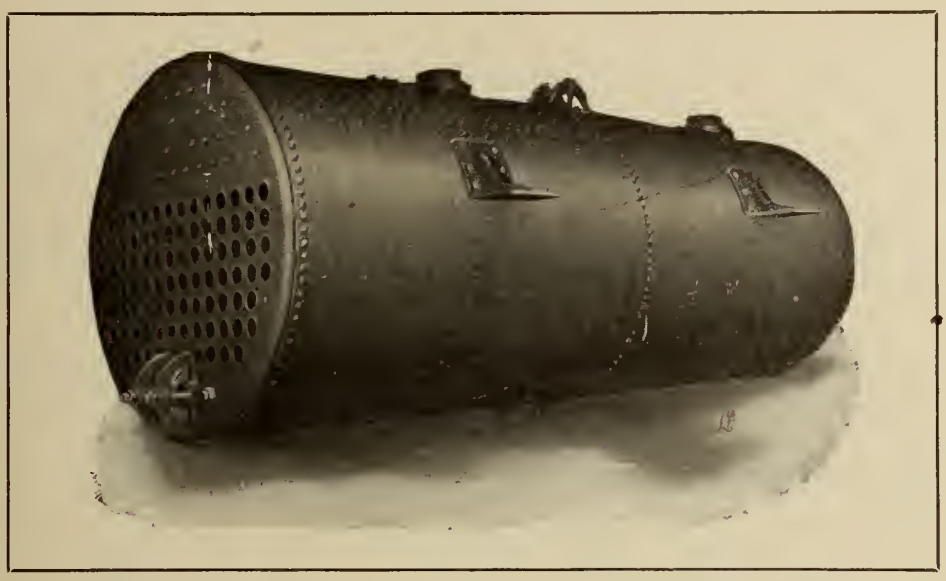

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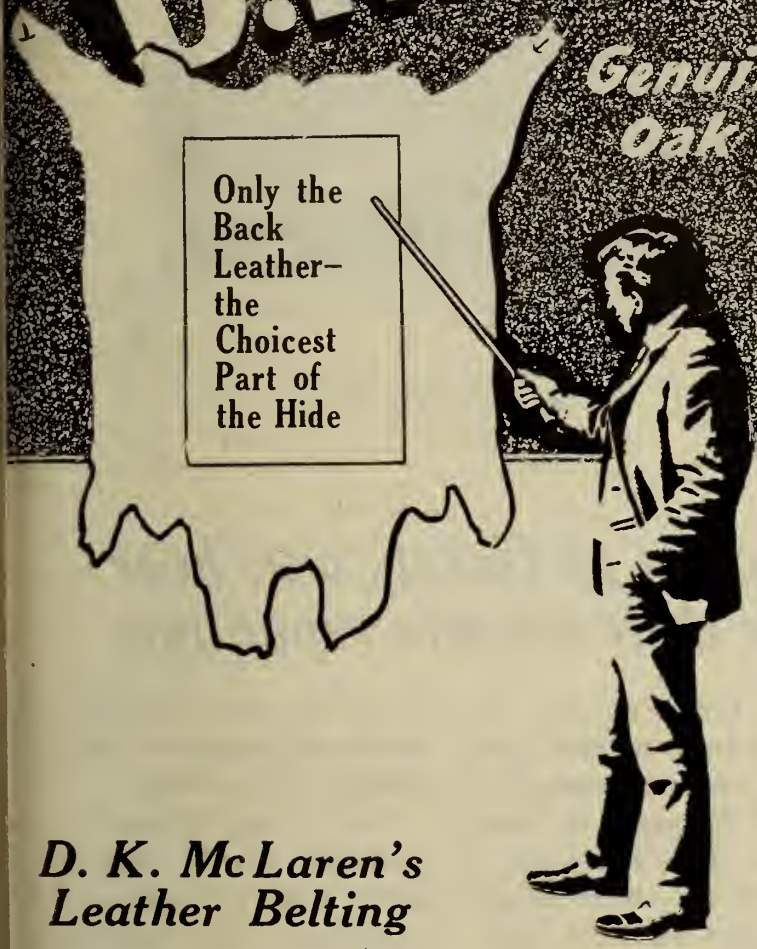

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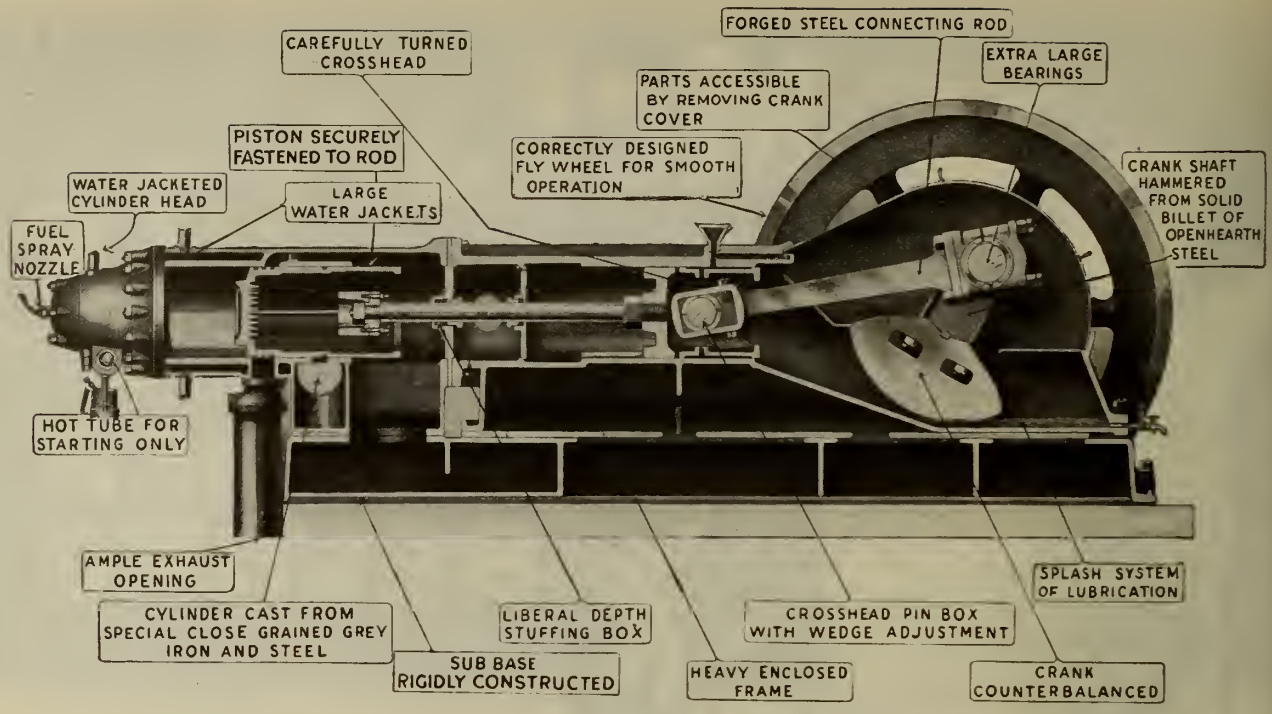
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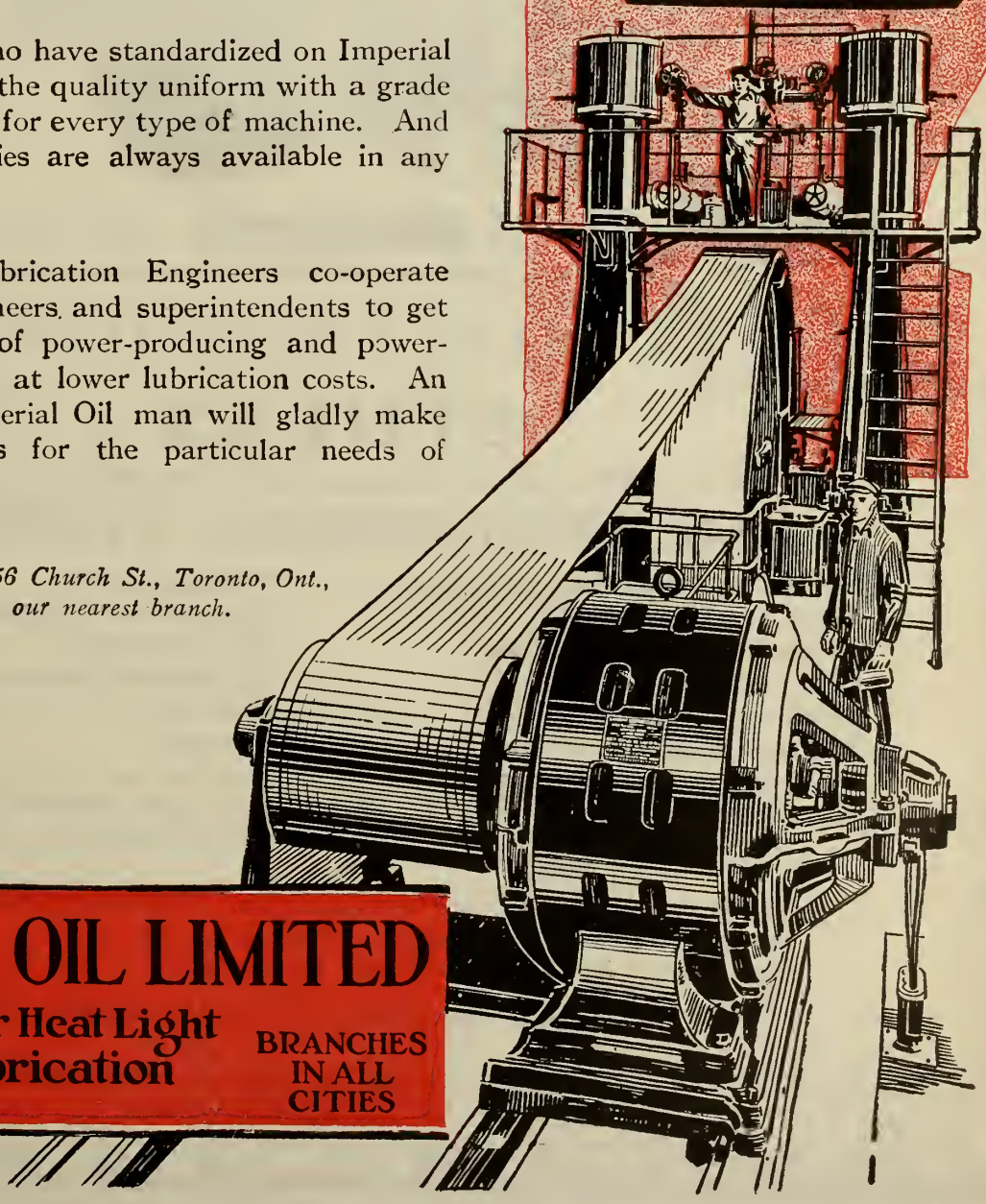

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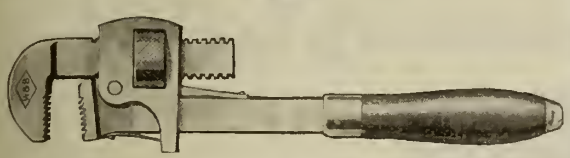

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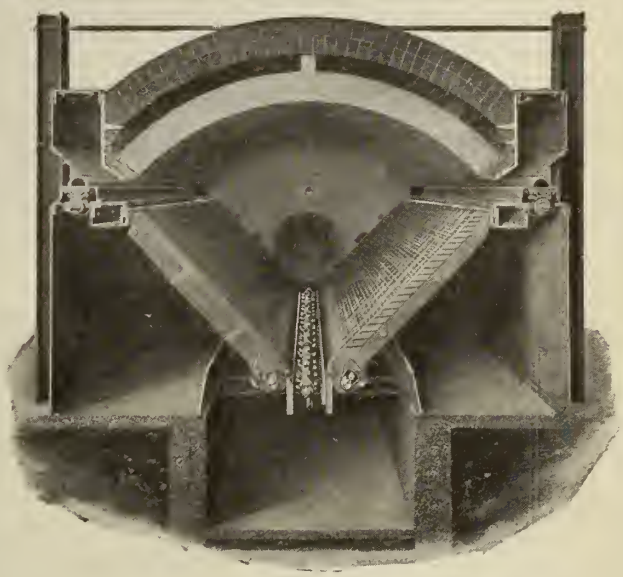

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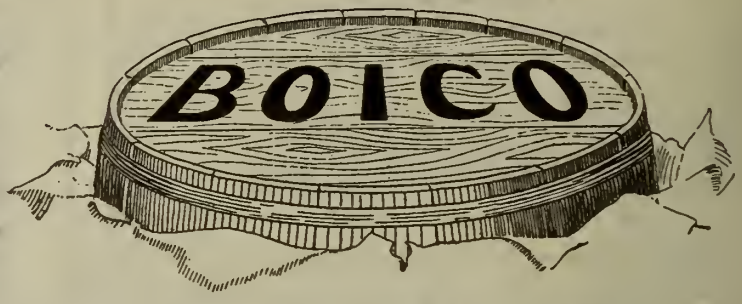

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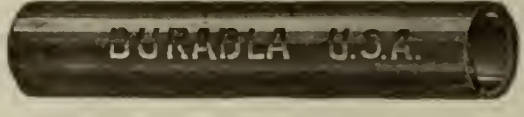
Etched on 

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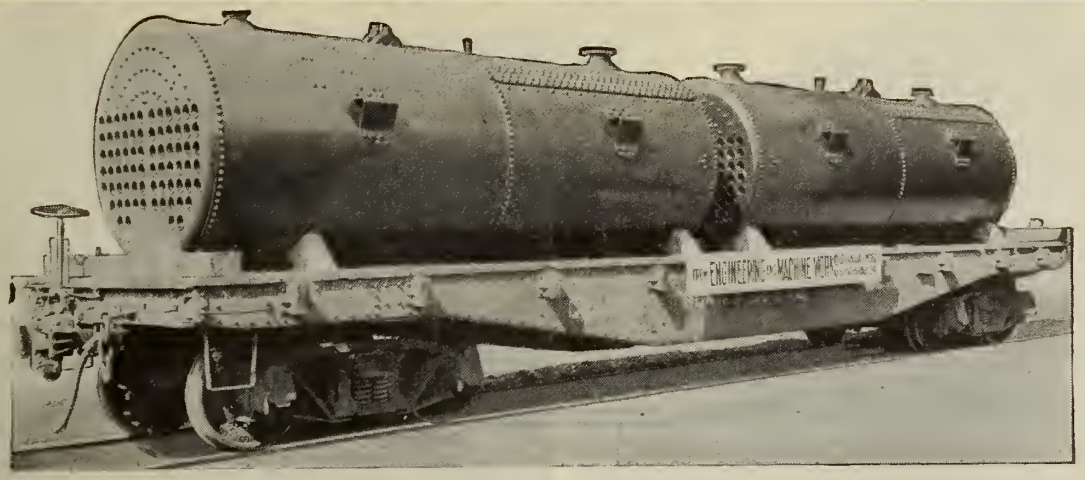

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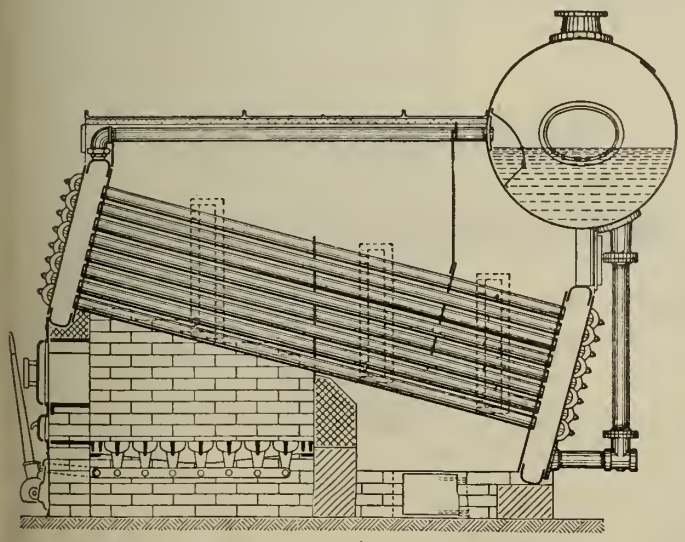

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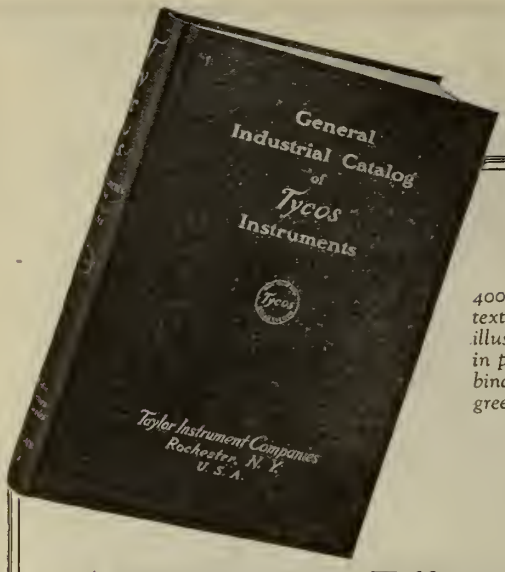

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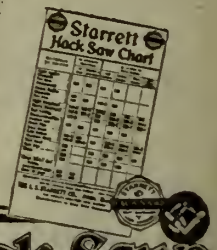

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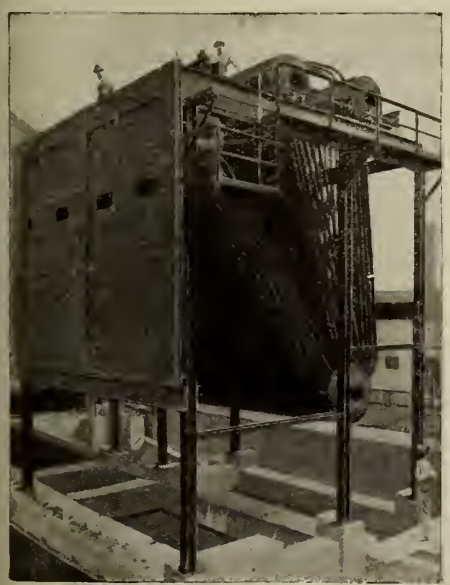

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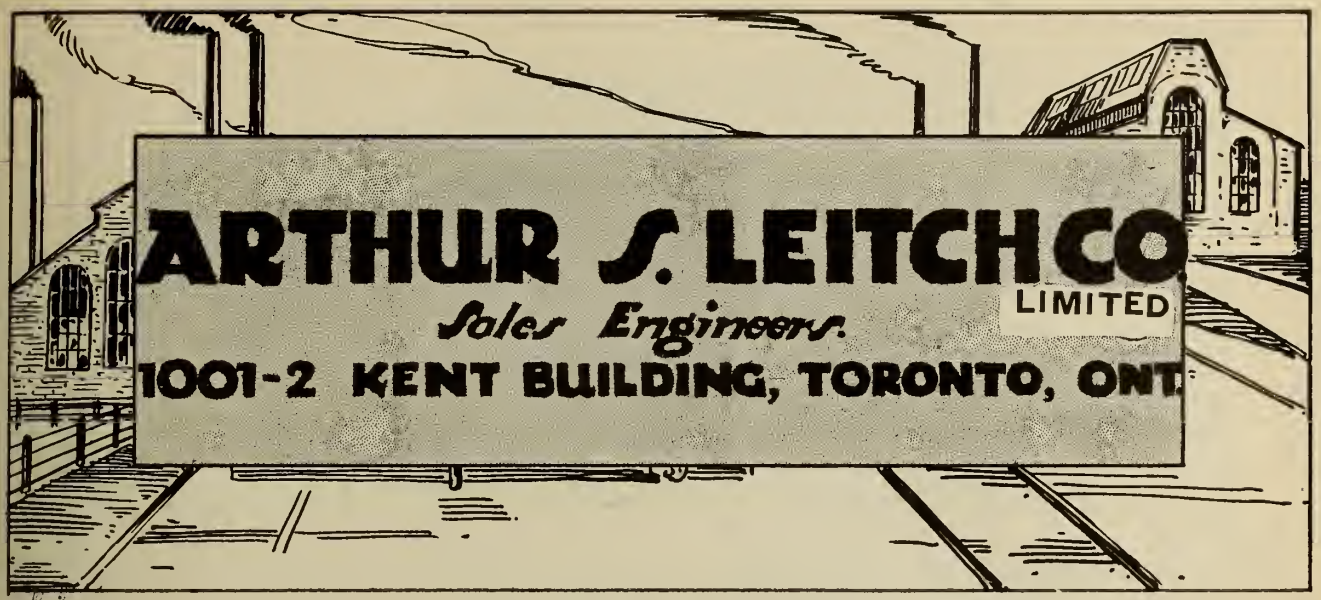

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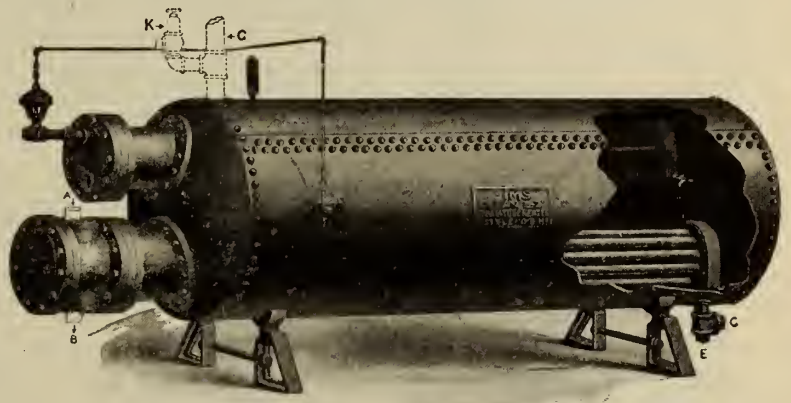

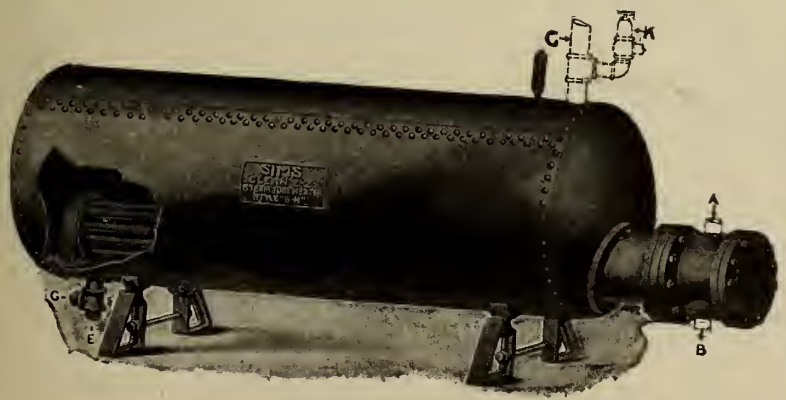

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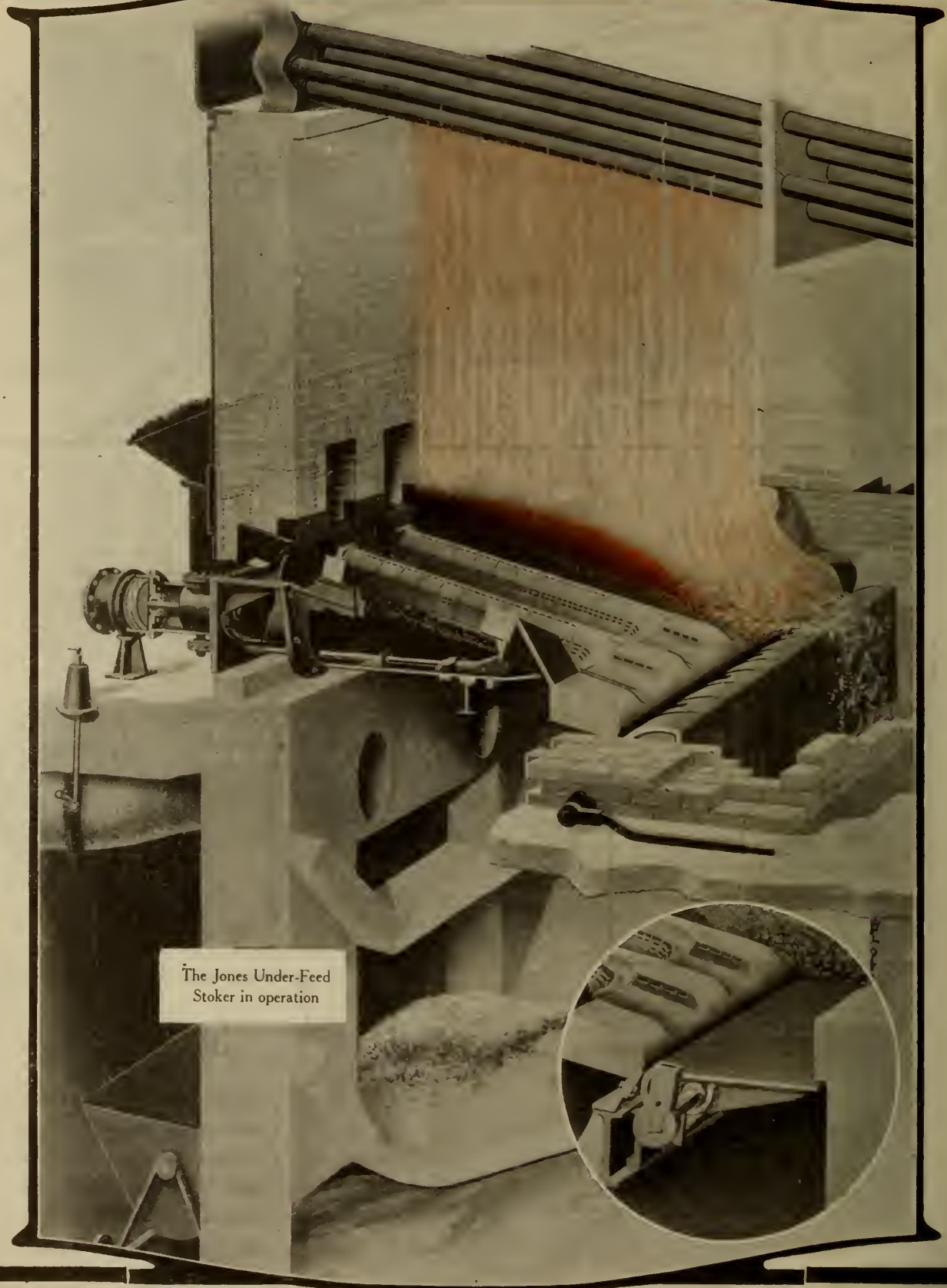

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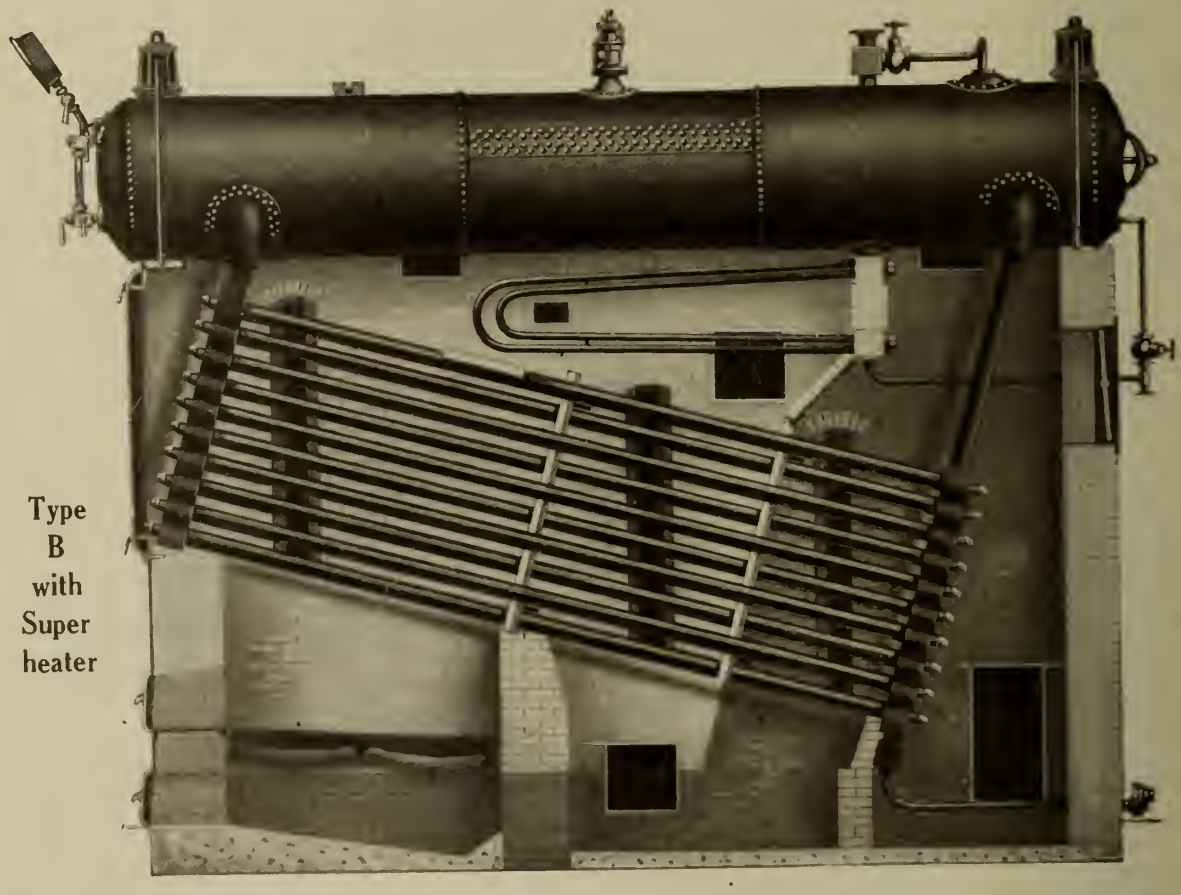

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Principles of Series and Compound Motors

Torque of a Series Motor—Speed of Series Motor—Comparison of Characteristics of Series and Shunt Motors—Compound Wound Direct-Current Motors—Differential Compound Wound Motor

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THE series motor is shown diagrammatically in Fig. 1. It consists merely of an armature and series field winding connected in series and almost invariably operated from a constant e.m.f. source and a constant impressed e.m.f. is assumed in the following discussion. Obviously, the current in the armature and in the field winding must, at any given instant, be the same.

The characteristics of the series motor are shown graphically in Fig. 2-II where they may be conveniently compared with those of the shunt motor of I.

The torque of a series motor, when the magnetic-circuit iron is being worked well below the saturation point, varies nearly as the square of the current. Thus, motors of this type have splendid starting torque. Torque varies as the product of flux, ΦP, and armature current I A. Now in a series motor, if the current is doubled, the flux is also doubled (approximately), since the armature current traverses the field coils. Hence, the torque (proportional to: current x flux) is increased four times. When the load being driven by a series motor increases, the motor slows down, hence its counter e.m.f. decreases. Then its current increases and its torque increases as the square of the current tending to assist the motor in pulling the load.

The speed of a series motor varies (Fig. 2-II) with the load. For any given h.p. load which a certain series motor is driving, there will be a certain definite speed. With a heavy load, a series motor will operate at slow (relatively) speed. With a light load it will operate at a high speed. With no load it will, theoretically, operate at an infinite speed, that is, it will "run away." The explanation of this is:

Any armature always tends to operate at such a speed that the sum of the volts lost in its armature, in I R A drop, and the volts counter e.m.f. induced will equal the impressed voltage. At heavy loads the current, and consequently the I R A drop in a series motor armature, will be

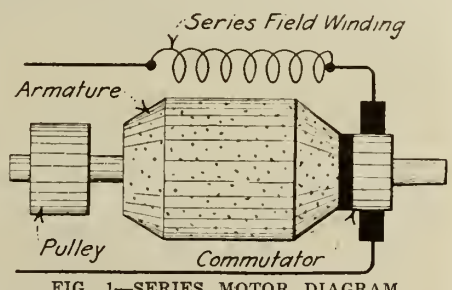
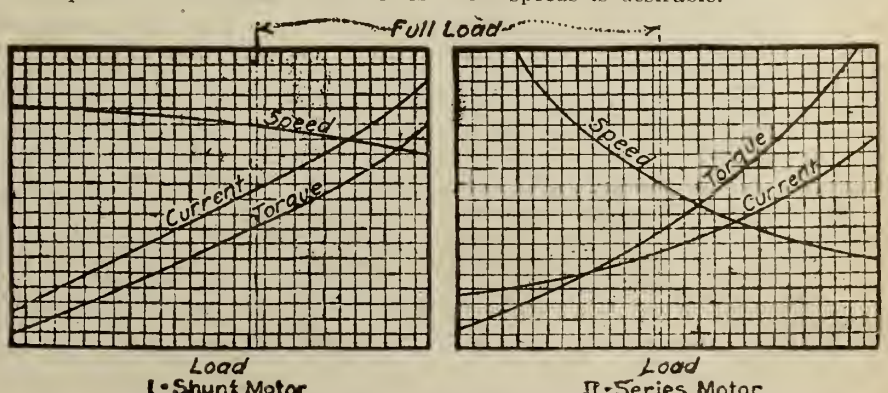


FIG. 1—SERIES MOTOR DIAGRAM

large and it is not necessary for the armature to rotate very rapidly to induce the required counter e.m.f. But suppose the load is thrown off the motor. There now being no resisting torque the motor speeds up, inducing a higher counter e.m.f. and decreasing the current through the field coil and armature. This weakens the field, causing a further increase in armature speed, which again decreases the counter e.m.f. With a series motor operating without load this process continues until the armature "bursts," due to great centrifugal stresses.

A comparison of the characteristics of series and shunt motors is given graphically in Fig. 2. Since in the shunt motor the field is practically constant, its torque varies directly with the current (approximately). As shown above the torque of a series motor varies almost as the square of the current. The series motor has, then, a much greater starting torque than has the shunt motor. Hence, a series motor of a given size, that is, weight, will start a much greater load than will a shunt motor of the same weight. The shunt motor has a practically constant speed for all loads within its capacity, while the series motor has a certain speed for each load—its speed varies with the load.

The applications for which the series motor is adapted are limited because of its speed and torque characteristics which are described above. The motor is not adapted to drive loads the power required by which varies, but which should be driven at a constant speed. The reason is that the speed of a series motor varies with the load. Hence, series motors are not, in general, adapted for machine tool or line shaft drives. If it were used for such, the speed would be low when the load driven was great and high when the driven load was light. Furthermore, since a series motor will "run away" at no load, it should be applied only where it can be geared or otherwise permanently connected to its load. Crane, hoist and railway traction application are good examples of services for which the series motor is well adapted. In other words, the series motor is fitted for conditions where constant speed is not necessary but where great torque at low speeds is desirable.



CHARACTERISTIC CURVES OF SHUNT AND SERIES MOTORS.

In starting series motors an adjustable resistance is connected in series with the motor across the source of impressed e.m.f. (Fig. 3) to prevent an excessive rush of current at the instant of starting while the armature is stationary and inducing no counter e.m.f. As the armature attains speed, the effective resistance of the rheostat may be decreased by turning the handle. The function of this starting resistance is the same as that of the armature resistance used in starting a shunt motor.

The speed control of series motors is effected by changing the resistance in circuit between the motor and the source of constant e.m.f. The same rheostat (Fig. 3) may be used for this as is used for starting the motor, providing its resisters have sufficient current-carrying capacity to prevent their overheating in speed-control service. The method is somewhat similar to armature speed control for shunt motors. It is subject to the same disadvantages. When the effective resistance of the rheostat is

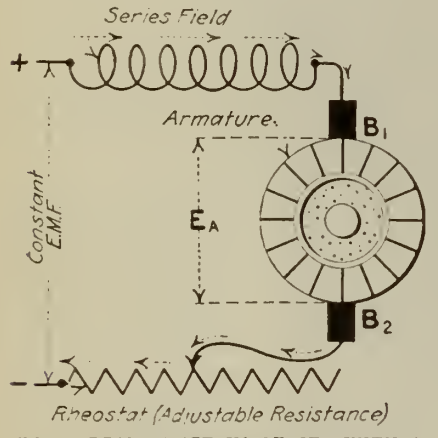


FIG. 3—RESISTANCE IN SERIES WITH A SERIES MOTOR.

varied, the voltage across the armature, E A, Fig. 3, is varied accordingly and the armature then "speeds up" or "slows down" correspondingly until its counter e.m.f. equals (approximately) the e.m.f., E A, impressed across the armature. Thus while it is true that a series motor has a definite speed when driving any given load with a given e.m.f. impressed across its armature, its speed when it is pulling a given load may be altered by changing the e.m.f. across the armature.

Series motors are extensively used for driving electric cars because their torque and speed characteristics render them especially fitted for this service. Shunt motors would not be well adapted for propelling a car as they would tend always to drive the car at about the same speed and on grades and in starting the motors would be greatly overloaded. Practically all of the cars in city service are driven by series direct-connected motors. Many of the cars and locomotives in suburban and trunk line service are also driven by direct-current series motors although alternating-current motors have recently been applied to some extent for this work. Cars are equipped with two or four motors so that the

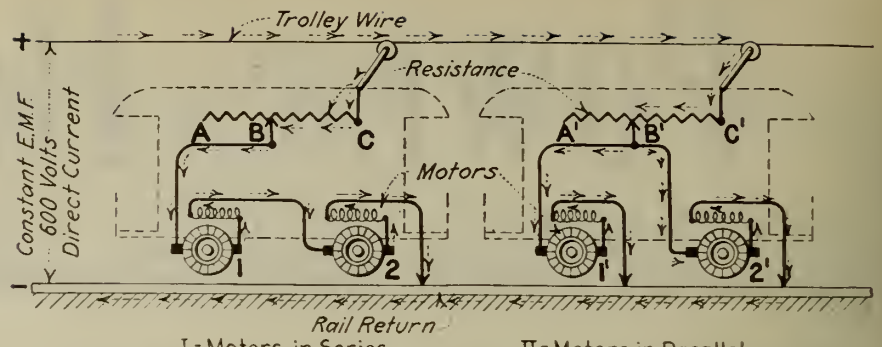


FIG. 4—SHOWING HOW TWO SERIES MOTORS DRIVING A STREET CAR ARE FIRST CONNECTED IN SERIES AND THEN IN PARALLEL.

torque may be applied at both trucks and so that series-parallel control (Fig. 4) may be used.

Series-parallel car control is used principally because it is economical. The controller located on the car platform and operated by the motorman is merely a rotary switch whereby the different series and parallel connections of the motors may be effected. Briefly, the operation is this:

Refer to Fig. 4. Advancing the controller handle to the first "notch" connects both motors, 1 and 2 (Fig. 4), in series with all the starting resistance A C in series also. As the controller handle is swung around the starting resistance is gradually cut out, meanwhile, until both of the motors are connected directly across the line without any intervening starting resistance. Throwing the controller around another notch connects the motors in parallel between trolley and rail but again in series with all of the starting resistance A'C'. As the car accelerates the controller handle is swung around until the motors are connected directly in parallel between trolley and rail.

The notches whereat the motors are connected without resistance: (1) in series between trolley and rail and (2) in parallel between trolley and rail—are termed running notches and are shown by longer raised marks on the controller top-casting than are the others. When the controller handle pointer is over either of these marks no power is being wasted in starting resistance—all power as taken from the line (except motor losses) is being expended by the motors in propelling the car.

Where the two motors are connected in series, only half the line current is required to start the car that would be necessary for starting with the motors in parallel. Assume that it takes 50 amp. through each motor to start the car. With the motors in parallel 100 amp. would flow from the line, but with the motors in series only 50 amp. flow from the line. With the motors in parallel resistance in series with them it would be necessary to limit the current through each to 50 amp. But with the motors in series each motor takes the place of a starting resistance for the other. Thus the economy of series-parallel control is obvious.

Compound-wound direct current motors partake of the characteristics of both shunt and series motors just as compound-wound generators partake of the characteristics of both series and shunt generators. Fig. 5 shows typical characteristic curves for a compound-wound motor. A compound-wound motor may be made to approximate more or less the characteristics of a shunt or a series motor respectively by making the amp. turns of its shunt or series windings more or less powerful proportionately. The elementary connections of a compound-wound motor are the same as those of Fig. 6 for a compound-wound generator.

A differential-compound motor has its windings connected as shown in Fig. 7-I. Its series-field winding "bucks" or opposes its shunt-field winding. A motor of this type can be arranged to operate at an almost exactly constant speed under varying load. As the load increases and the motor tends to "slow down" the series-field magnetization increases and

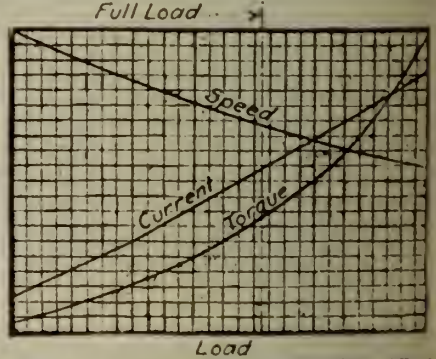


FIG. 5—CHARACTERISTIC CURVES OF A COMPOUND WOUND MOTOR.

since it opposes the shunt-field magnetization (which is normally greater than the series magnetization) the resultant field is weakened and the motor maintains the same speed as before. Of course the proportion of shunt-field turns and series field turns must be exactly correct if this result is to be attained. If the ratio of turns is such that the series turns are more powerful than the shunt turns, the motor will "speed up" under increased load. The speed regulation of a differential-compound motor may be closer than that of a shunt motor but its starting torque is not as great.

A cumulative compound motor is so connected that its series turns augmen

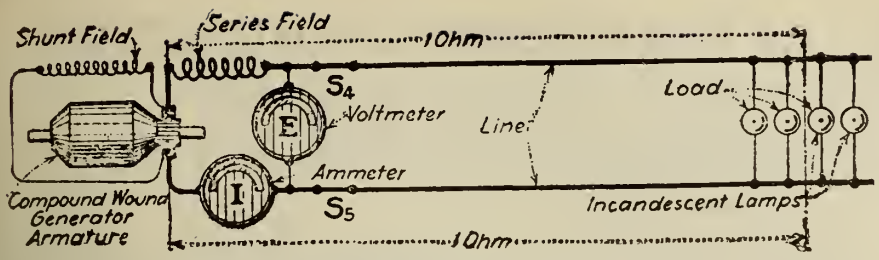


FIG. 6—COMPOUND WOUND GENERATOR SERVING LOAD, WITH INSTRUMENTS IN CIRCUIT FOR TAKING CHARACTERISTIC DATA.

the shunt-turns magnetization as shown in Fig. 7-II. A motor thus connected will have strong starting torque, stronger than that of a shunt motor, but its speed regulation will not be as good. Motors of this type are used for shears, rolls and similar applications where close speed regulation is not necessary but where great torque may be desirable at starting and while running. Frequently motors of this type are merely series machines provided with sufficient shunt turns to prevent the motor from "running away" when operating at no load.

The starting and control of compound

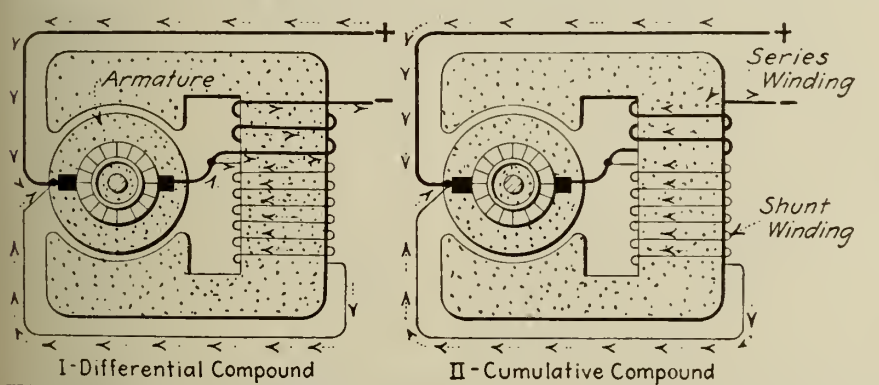


FIG. 7—DIAGRAMS OF DIFFERENTIAL AND CUMULATIVE COMPOUND WOUND MOTORS.

motors is, in general, similar to that for shunt motors. The same starting rheostats can be used for ordinary compound as for shunt motors. Ordinarily the series winding has no special connection to the starting rheostat. Sometimes provision is made whereby the series winding may be shunted out of circuit after the motor has been started. The possible special-control arrangements are too numerous to enumerate.

TIDAL PLANT AT SEVERN RIVER

More details of the 500,000 horsepower tidal-hydro-electric scheme, fathered by the British Ministry of Transport and first reported by cable several weeks ago, are contained in a recent issue of the London Electrician. This ambitious plan, which aims at the production of 500,000 horsepower in a ten-hour day, with a peak load of 1,000,000 horsepower, at an estimated cost of a little more than 1 cent per kilowatt-hour, is based on the construction of a dam across the Severn River and the utilization of the tidal power. With the project are linked in plans for an extensive highway and railway development and for a locked basin for shipping purposes, 27 square miles in extent, a very large portion of which would, it is held, be suitable for the accommodation of vessels of the largest size and which would be usable at all stages of the tide.

There would be two separate installations required, a great concrete dam across the Severn, within which sluices and turbines would be installed for utilizing the power of the tides and with which would be combined a road bridge and a railway bridge, and a high-level storage lake and tunnel with a pumping and turbine house on the banks of the tidal portion of the Wye River, which empties into the Severn. It is proposed that water be forced up from the low level of the Wye through a 40-foot tunnel driven through more than a mile of solid rock. The sea water would be pumped into high-level reservoirs during the rising tide, and this stored water would be used to supply the turbines at ebbing tide. The site which has been selected for the barrage lies close to the line of the existing railway tunnel between South England and South Wales at a place where the estuary is about 2½ miles wide with low-lying country on each side.

It is held that the power available on the Severn exceeds all the other potential sources of inland water power within the United Kingdom and is also unique in combining all the conditions essential to the economic development of tidal water power on a large scale. These conditions present an exceptionally high range of tide, an estuary of large capacity, an ideal geographical situation in relation to the industrial centers of the country, and suitable land along the banks of the river for the development of industrial operations. The capital cost of the scheme is not explicitly stated, but the Electrician understands that £30,000,000 is about the figure, exclusive of expenditure for transmission lines.

C. A. S. E. HAMILTON

Monday, March 7, the C.A.S.E. No. 2 held an open meeting at which a lecture and slides on the Green Economiser was given and much enjoyed by all, some of the men present having worked for the Green Economiser people in England. We appreciate the kindness of that company in sending the slides through Executive Secretary Brother L. J. Ellis.

It is the intention of the officers of the lodge to have an open meeting the first meeting night of each month.

INTERESTING TURBINE INSTALLATION

An interesting feature of turbine operation is recorded in the installation of a 55 horsepower De Laval turbine in a herring drifter. The turbine is geared down to operate twin screws, and is used to help the sail as well as for propulsion when there is no wind. The interesting feature from the engineering point of view is that owing to the fact that the quantity of steam passing the nozzles did not vary to any appreciable extent with variations in the velocity of the turbine, but only with the steam pressure, the turbine became much more efficient with higher speeds. This occurred when the vessel was sailing, the turbine revolving much faster owing to the decreased resistance, and the combined speed with sail and steam was about equal to the sum of the speeds achieved with either motive power separately.

BURNING FUEL OIL

Set the burners open wide,
Do not touch the valves at side;
Keep the pressure on the pump,
And up the bally steam will jump;
If the smoke is black and thick,
Open up the fans a bit;
If the smoke is thick and white,
To slow the fans will be quite right;
For when sufficient air is given,
No smoke ascendeth up to heaven.
If the jets refuse to squirt,
Assume the cause is due to dirt.
Should the flame be short and white,
You have combustion clear and bright;
But should the flame be yellow and long,
Combustion is entirely wrong.
A wise man to his heater sees,
And keeps it 200 degrees;
To have it more is not quite wise,
Because the oil may carbonize;
A little lower has been found
To give as good results all round.
If the filters are kept clean,
No rise in pressure will be seen;
But should the pump kick up a ruction,
There's likely air within the suction.
The pressure governs the supply,
So do not keep it very high.
If these instructions you will follow,
You'll beat the other fellow hollow.

Extract from "Marine Engineering Knowledge," W. C. MacGibbon.

Changing of Lap to Butt Seam Construction

Effect of the Unequal Rolling of Plate Edges in Lap Joint Construction—The A.S.M.E Code Regulation as to Age of Boilers With Lap-Jointed Longitudinal Seams—Lap Seam Cracks Seam Cracks

NOT long after the steam boiler came into general use in America considerable discussion was aroused with respect to the question of limiting the life of a boiler, says the Locomotive. Numerous instances of serious accident, which it seemed impossible to account for, had impressed many with the idea that a boiler, like any other piece of apparatus, was subject to deterioration from constant use and that therefore it would be best to take a boiler out of service after a certain period. In fact, a number of concerns followed this practice. The majority of boiler users and engineers, however, felt then as they do now that rigid inspection would safeguard their boiler plants and would furthermore be of greater service in the interest of economy, for it was admitted that many boilers had served for twice the life that, by some, had been allowed for safety.

The plan of relying on inspection for a forewarning was adopted and served well, but there were a number of unaccountable explosions in boilers of relatively short life. At the time, the majority of boilers in use were constructed with a longitudinal lap joint. A series of investigations was conducted to study the stress conditions in this type of joint and it was found that the construction, both from its fundamental shape and the conditions of manufacture, presented a most dangerous condition.

In the Locomotive for April, 1905, there appeared an account of the disastrous boiler explosion at Brockton, Mass., on March 20, 1905, and also an article on the "Lap Joint Crack" to which type of defect the explosion was said to be due. For the sake of clearness we shall present here some of the more important points which were brought out in the last named article.

When a boiler plate is rolled to a cylindrical form, the edges of the plate, in passing through the rolls, are not gripped as effectively as is the middle of the plate, so that the ends are left somewhat flat. The condition produced is illustrated in Fig. 1. This necessitates the plates being forced together at the edges and this produces an added stress that persists unless relieved by annealing. In addition to this the plates, if bent after punching, will bend along a line of rivet holes as shown in Fig. 2 in somewhat exaggerated form.

The elementary lap joint is illustrated in Fig. 3. If tension is applied as indicated in Fig. 4, the plates, in an attempt to align themselves with the load, will

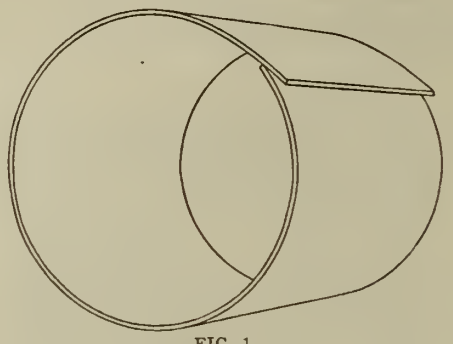


FIG. 1.

bend along a line running under the outer edge of the rivet heads.

The combined effect of all these conditions, together with the constant bending of these joints by changes of pressure when in use, is to impose excessive stresses in the surface of the boiler plate along the line just mentioned. This has produced, in many boilers, a crack which starts always from the inside or covered surface of the inside or the outside plate of the joint as indicated at A and B in Fig. 4. This crack may eventually work its way through the plate until it shows itself by breakage. But in many cases it may develop for some distance along the joint and yet remain absolutely invisible. Eventually the weakness may develop to the point of complete failure and a disastrous explosion.

Inspection is generally accepted as being safe for the determination of the fitness of a boiler for use. The lap seam crack, however, is invisible to all methods of inspection, except cutting out the rivets and separating the plates or the method described in the Locomotive for October, 1914. Recognizing the insidious danger presented in the lap joint for longitudinal seams in boilers, the Boiler Code Committee of the American Society of Mechanical Engineers formulated the following regulation: (Par. 380, A.S.M.E. Boiler Code, Edition, 1918.)

"The age limit of a horizontal return-tubular boiler having a longitudinal lap joint and carrying over 50 lbs. pressure shall be 20 years, except that no lap joint boiler shall be discontinued from service solely on account of age until 5 years after these rules become effective."

Some boiler owners may be of the opinion that the longitudinal lap seams of boilers of this type can be changed to butt strap construction and the boilers kept in service after the time limit. This change of design and construction is not approved, however, by those thoroughly familiar with steam boilers, for, although butt straps and more rivets may be added, the material along the line of the joint, which was abused and tortured by the forming of the lap joint and fatigued by the years of service which subjected it to the expansion and contraction brought about by the many changes of temperature and pressure, would be further abused on the portion of the original construction left after cutting off one side of the lap joint and forcing the edges of the plate into line to form a butt joint.

Assuming that a double riveted lap joint has been changed to a triple riveted butt construction, the joint, after placing the butt straps and riveting, would appear as shown in Fig. 5 on page 145 with the rivet holes of the original lap joint at B and the new holes at C. If a defect existed in the plate as shown at A the joint would be very faulty. Assuming the original joint as having the rivet holes spaced 3¾ inches and the additional holes spaced 6½ inches, if the plate material were defective or contained a lap crack as shown, the failure of the joint would require only the shearing of the rivets in long pitch, or 6½ inches, and the failure of the defective plate.

It might be argued that the exposure of the inside of the lap seam, when the change to a butt seam is made, would reveal the presence of a lap seam crack. A crack of this nature is, however, often present in a boiler of this construction after years of service, although it may not be visible to the naked eye. But,

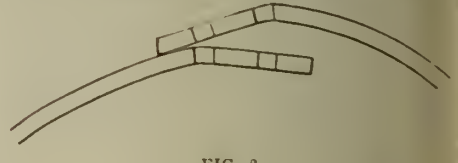
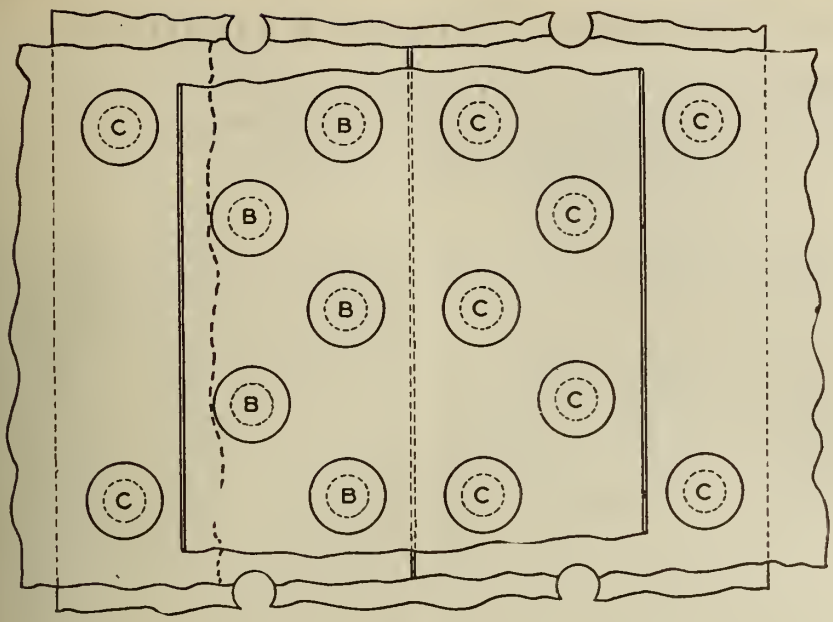


FIG. 2.

even though no crack exists, it must be remembered that boiler plate, like any other material, becomes fatigued after long years of service and for this reason, after it has been under stress for many years, it should not be subjected to a change of shape and torture of the material in an endeavor to keep the boiler in service, especially when there is evidence that the altered structure is defective.

The age limit of twenty years is none too exacting as will be evidenced by an explosion, resulting from a lap seam crack, of a boiler at the Tallahoma Lumber Co., at Mossville, Miss., on October 21st, 1920. This boiler was less than five years old. The explosion completely



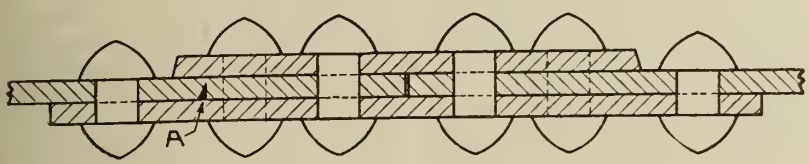


FIG. 5.

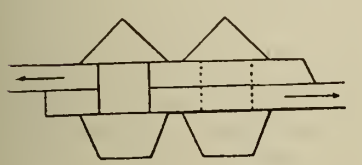


FIG. 3.

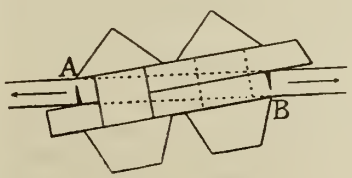


FIG 4.

wrecked the plant, killed three men and injured four others. There was no negligence on the part of the operators and there was ample proof that the accident did not result from low water or overheating. On the other hand, the lap seam cracks could be clearly seen in the boiler plates after the disaster.

Regulations such as we have quoted are not intended to be arbitrary. Railroad companies determine the safe load capacity for each of their freight cars and if they discover an overloaded car they refuse to transport it. This is done not only to avoid the possibility of straining or breaking the overloaded car, but also to prevent a possible wreck which might result in loss of life, property damage, and delay. In a like manner the Boiler Code Committee requests that steam boilers and pressure vessels be designed and constructed for a safe working pressure and that they be not subjected to overloads. The rule quoted above is sane and economic because it is intended for the protection of life, limb and property. So also should be regarded the action of the boiler inspector in condemning any construction regarded as unsafe.

STRAIGHTENING A ROTOR SHAFT

By D. A. HAMPSON

The method of straightening a rotor shaft described in the January 20 issue is both novel and instructive; it is one that should suggest a way out of other ticklish straightening jobs. There is no question but that there are unrelieved stresses in a shaft so repaired—if there is a suitable factor of strength in the original shaft and if the service is not fatiguing, no harm will result. The conditions under which a repair is performed often make it necessary to violate the teachings of theory, but if results are the true test of engineering, then such repairs must constitute good practice.

Some time ago a screw was brought into our place to be straightened. It was a piece of steel twenty feet long over all with fifteen feet of square thread, single, having a pitch of one inch and an O.D. of three. This screw was part of a special machine and moved a heavy carriage back and forth. Something had blocked the carriage and the screw, making 200 r.p.m., had bent close up to the nut. It was a job we did not want to do for obvious reasons, and we frankly told the customer so, but he did not want to send it away to the people who made the machines and he agreed to pay well for the time and accept all risk.

There was no lathe within forty miles that would take the length or over half of it, but we had a planer with a fifteen foot table, and by placing the screw diagonally (to dodge the slots), we were able to roll it on the top for sighting purposes. It was not hard to pick out the bend—a straight-edge would do that—but it is always of great assistance to rotate a piece being straightened.

Actual straightening was done by putting the bend down, with a block under this part to raise it half an inch from the table, and then drawing down on clamps on each side of the spot. The planer was a heavy one and we had no fear as to which piece would go first. Our fear was that we would get too far, and, worse, would get a reverse bend alongside the original one. To be safe, we bored out a piece of cast iron to three inches, and sawed it up into three pieces, putting a short section under the screw and longer ones under the clamps.

A swaging tool was also forged out and fitted to the space and curve between the threads. This was used to force back the metal where it had been compressed, thus assisting the clamps as pulled down, and putting a stress of compression in the metal where there would otherwise have been only the tension due to drawing the screw back to a straight line. As the clamps were pulled down, this swaging, or peening, was carried on—greatest at the point of bend and tapering off in amount for a couple of threads each side.

After a cautious trial of this scheme, followed by more confident repetitions, we pronounced the screw commercially straight. Indeed, it was a first-class job and surprised us ourselves. There was a certain amount of stretch at the critical point, that we knew, but as it was not discernible with a rule and showed up only when calipers were applied, we thought there would be no interference in passing through the nut—and luckily there was none.

WASTE OF NATURAL RESOURCES

As an example of how natural resources are thrown away, the following is reported in the Mexican press. The oil coming from the subsoil in the oil well district is mixed with a certain quantity of natural gas. This is separated from the oil before the latter is sent through the pipe lines, and the gas is then taken a considerable distance from the oil fields and burned. An investigation by the Department of Industry showed that three wells alone were producing and wasting in this way 1,200,000 cubic meters of gas per day. From this gas it would be possible to extract something like 60,000,000 litres of spirit per year.

Features of the Unaflow Steam Engine

History of Development—Cylinder Condensation—Unaflow Construction—Unaflow Engine Economy—The Flat Economy Curve Shown by This Type of Engine Under All Loads

By ROBERT CRAMER

NOT being connected with any manufacturer of unaflow engines, I am not an advocate of this engine in the usual sense of the word. My interest in the unaflow engine comes from the fact that from the very inception of this type of engine, I have helped to develop it; and I therefore believe that I am in a position to give you facts and information which will be interesting. The gentleman who spoke before me said that in no case was it a wise thing to say or even possible to say offhand that one engine, one type or another type, is just the suitable thing. That is true. You will have to investigate conditions in order to decide that question. Each type of engine has its merits. An oil engine drive has its merit in given cases and the electric drive has its merits and so has the steam engine.

It has been predicted for a long time and through many years that the steam engine will ultimately be driven from the field. First it was the steam turbine. Then it was the internal combustion engine and it is a remarkable fact that whenever another prime mover has gained a start on the steam engine that the steam engine usually has followed to a certain extent. In other words, it has reclaimed part of the field which had been taken from it. That is the case with the unaflow engine. The remarkable thing about the unaflow engine is that in small units, units down to as small as 50 horsepower, it can show the same steam economy as the largest steam turbines.

Electric drive in the majority of instances is derived from steam. If the very economical oil engine has difficulties in competing with electric drive in many instances, why doesn't the same thing hold good with the unaflow engine, which, as I just stated, is as economical as some of the very largest steam turbine units.

History of Development

The unaflow engine was conceived, I believe, in 1907 or 1908 in its present form. The idea really is old, but in its present form it dates from either one of those years. Since that time en enormous number of unaflow engines have been installed in Europe. I have no definite information as to the number, but a real start with the unaflow engine was made in the United States only as late, as I think, 1913, and since that time there have been installed under all kinds of conditions in the United States over one thousand engines. They aggregate approximately 350,000 horsepower. This showing will probably surprise a good many.

The old types of steam engines, the old slide valve engines, or, further back than that, the old engine of Watts type used approximately, ranging from 60 to 200 pounds of steam, per indicated horsepower, per hour; and efforts were made right from the start to improve the economy of these engines. There were two important causes for the lack of economy, that is, low steam pressure and lack of high vacuum. Steam pressures have been raised until to-day we have central stations which work on pressures up to 350 pounds. There are large steam turbine plants. Condensers have been perfected until to-day steam turbines operate with a vacuum as high as 29½ inches, or within half inch of the theoretical possible vacuum. This all shows that the source of economy, is increase of pressure, or, to put it more scientifically, increase of the temperature range through which the steam passes.

Cylinder Condensation

Unaflow engines, however, tackle an entirely different cause of loss. Every practical engineer who is acquainted with the steam engine is familiar with the term "cylinder condensation" and in a general way it is well understood what that term means. When you put steam into a cylinder under ordinary conditions, at say, 350 degrees, according to the steam superheat conditions; this steam will impart heat to the cylinder wall and will cool as it expands. If it is expanded down to the pressure in the condenser it will cool down to the temperature in the condenser, which with a high vacuum, is around 100 or 120 degrees. There you have a range of over 300 degrees in temperature. It stands to reason that by the time that steam has been exhausted from the cylinder, the cylinder will not have the temperature of the incoming steam; but while it is warmer than the exhaust steam it will be cooler than the incoming steam. The temperature will be somewhere in between. Then on a new stroke, when the steam is admitted, it comes in contact with the cooler cylinder walls; and the natural result is condensation of a certain portion of the steam, which, of course, can't do any further work. When the strokes follow each other at the rate of anywhere from 75 to 300 times a minute, the temperature influences are very marked.

In order to avoid this loss one of the most remarkable steps in the development of the steam engine has been taken in compounding engines. If you compound an engine in such a way, which is the best illustration of our case, that the temperature range of about 300 degrees is cut in half; in other words, the temperature range in a high pressure cylinder is, say 150 degrees, and in the low pressure cylinder the temperature range is the same; then the temperature differences between the cylinder walls and the incoming steam are cut in half. The cylinder condensation is also cut in half and the economy is improved. It is a matter of everyday experience that the compound engine is much more efficient in steam economy that the single cylinder; and the triple expanding engine is still better, while the quadruple expanding engine is supposed to be better, although there are other sources of loss which makes this doubtful.

Unaflow Construction

The unaflow engine was in the beginning an attempt to obtain the economies of the compound engine in a single cylinder. From the practical point of view, the outstanding feature of the unaflow engine is its central exhaust belt. The central exhaust port is the one distinguishing feature of the unaflow engine. You have in the center a hollow band or a belt, arranged around which are a number of ports. At the center there are a number of holes cored into the cylinder and a steam-jacketed head is fitted, which is usually notched in, but these details are not of any consequence in our discussion.

The piston is almost as long as half the stroke, and starts with a properly proportioned clearance. The length of piston is half the stroke minus the width of the cylinder ports. You can see as this piston moves it will finally overtravel the exhaust port. When steam is admitted the piston moves a certain distance, at which point the steam is cut off, and then expands up to the second point, where the piston over-travels the exhaust port. At that moment the exhaust starts. While the exhaust can only be short, because the piston returns and cuts off the exhaust; still this is the time during which the piston travels most slowly, that is, when the crank goes through the dead center; and while this in general practice is only about one-tenth of a stroke, in time it represents about one-quarter revolution or about 90 degrees of crank motion, so that the steam has plenty of time to exhaust. In the diagram it looks like this. The clearance is usually proportioned so that the compression just reaches the initial pres-

sure. During compression the steam is heated. Air is heated in compression and so is steam. If the steam is wet it is dried and if it is dry it becomes greatly superheated. In actual practice, as has been proven by experiments, the compression space is filled with steam which is a good deal hotter than the incoming steam. When the new charge of steam is admitted, there is no cylinder condensation. On the contrary, a part of the heated steam is driven back into the steam pipe. This is theoretically the basis of the unaflow engine elimination of cylinder condensation, but here enters a peculiar fact.

If you built an engine embodying nothing but the things which I have emphasized, that engine would be no more economical than a common engine. This is a surprising fact and shows that any theoretical deduction of this kind needs the correction of hard practical fact in order to make it workable; and that hard practical fact in this case is the addition of a head jacket. To-day, the typical unaflow engine is the combination of an engine with a central exhaust and a head jacket. If you leave off the head jacket you have nothing, but with a head jacket, when you expand to the end of the exhaust period, you have steam, which is about in the condition of that in the condenser; but this steam is continually in contact with the jacket heated by steam of the boiler temperature, so that it becomes heated. Any moisture present is driven towards the exhaust and out, so that the steam is dry. When compression begins and the steam becomes highly superheated, the interior of the clearance space is a good deal hotter than the incoming steam. In other words, you have the principle of the unaflow engine, exaggerated, and this makes for economy.

Another peculiar fact emphasizes the point that theoretical features need practical correction. Suppose I were to build a unaflow engine for non-condensing operation. If I take a volume of steam equal to nine-tenths of the stroke as atmospheric pressure and compress it into a clearance to obtain initial pressure, that clearance will have to be very large. Engines of that kind have been built that have clearances up to 14 per cent. Every practical engineer knows that large clearance is one of the things that destroys steam engine economy. If you want to study this in its reference to the unaflow engine; to design such an engine that will give good economy, with large clearance, you must have an engine of extreme size, because you must work with a very low pressure.

An engine was built for non-condensing service, but the clearance was made so small that the pressure at the end of the compression stroke would greatly exceed the initial pressure. In order to offset this an additional exhaust valve was placed in the engine, and was kept open during part of the return stroke. This is a clear violation of the unaflow engine principle; but reducing the clearance gets a better mean effective pressure and increases the economy. That part of the unaflow engine principle which obstructs is sacrificed. The result is a smaller engine that has exactly the same economy as the larger unaflow engine of large clearance.

As a matter of fact, the leading unaflow engine builders to-day use four valves in addition to the central exhaust port. The opening of the exhaust valve is adjustable so that the engine can be suited to any exhaust condition.

Unaflow Engine Economy

With a non-condensing engine operating on saturated steam under 100 pounds initial pressure, you can obtain an economy of 23 pounds of steam per indicated horse-power hour. That is excellent if you compare it with saturated steam, 100 pounds, non-condensing engine of any other type. As you improve the steam pressure and superheat conditions the economy improves. If the pressure is 200 pounds, and other conditions the same, the steam consumption is cut down to 18 pounds. At 100 pounds initial pressure with 100 degrees superheat, this engine will consume at the best mean effective pressure about 20 pounds. At 200 pounds pressure this is reduced to about 16 pounds.

The condensing unaflow engine, using saturated steam, of 100 pounds initial pressure, and with 27 inches of vacuum, the steam consumption is about 13½ pounds per indicated horsepower. If the pressure is raised to 200 pounds, other conditions the same, then the steam consumption will be about 12½ pounds per horsepower hour. Using 200 pounds pressure and 100 degrees superheat the steam consumption will be just a shade over 10 pounds per horsepower hour. This equals the best turbine practice in the country.

These are figures of actual practice to-day. They are guaranteed by the manufacturers of the unaflow engine. Some engines have been built by some famous European builders like Sulzer Brothers of Switzerland that have shown a steam economy of 8¼ pounds per horsepower hour, under ideal refined test conditions. You could not get figures as low as that in regular practice.

These figures are the steam consumption of a unaflow engine at the best mean effective pressure. You know the economy of any engine is best at a certain load and usually as you increase the load the economy is less and when you decrease the load the economy is less. In a compound engine the loss of economy due to deviating from the standard load, the best load, is very marked. If you overload a compound engine the economy is all gone. If you only partly load it your economy is also low. With the unaflow engine this is practically overcome. It has what the engineers call a flat economy curve. If you plot it on the basis of the load you will find that you will have only a very slightly curved line.

I have figures taken from tests under commercial conditions on two small engines driving a 100-kilowatt generator. One was of the condensing and the other of the non-condensing type. On the condensing engine, when the load was increased 50 per cent. the steam consumption increased 3 per cent. per indicated horsepower hour. At a quarter load the steam consumption was 7 per cent. higher. The non-condensing engine did not do quite as well. The record on that engine shows that for 50 per cent. increase of load the steam consumption increased 8 per cent. and for quarter load it also increased 8 per cent. over the best.

But this flat economy curve has a peculiar commercial influence. To-day when an engine is built for 100 kilowatts, it is not proportioned so as to have the best economy at 100 kilowatts; but the engine is reduced in size so as to give the best economy at approximately two-thirds of rated load. This means that the engine costs a good deal less and if you take into consideration the economy, the money invested and the repairs and upkeep; the engine is more economical than a full sized engine which would give a lower steam consumption at the rated load. That is regular commercial practice to-day.

But the flat economy curve has another influence. Take a compound engine and reduce it just as highly as you know how. Heat the receiver and take all the other precautions and you will improve the economy of the engine. You can build that engine so as to show a better economy than the commercial unaflow engine, but just as soon as you have any variation of the load, the unaflow engine will show a better steam consumption economy than the compound engine.

(Presented at the annual meeting of the National Association of Practical Refrigerating Engineers.)

The Elk Fire Brick Company of Canada, Ltd., Sun Life Building, Hamilton, have issued a bulletin describing their products. This company manufacture refractory brick in all shapes, for furnace linigs, blast furnaces, cupolas, fire brick arches, checker brick, etc. The catalogue illustrates every different shape, and gives information on the sizes available, and the guarantees given, also the deviations from specifications allowed. The shapes shown have been adopted by the Refractories Manufacturers' Association as standard. In addition to the foregoing there are a number of tables showing numbers of bricks required of various shapes to make certain size linings. Other useful tables are fusion points of different materials, and comparison of the different thermometer scales, circumference and areas of circles, and weights of various materials.

A Course of Instruction For the Graded Certificate

Some More Examples of Zeuner Diagrams and Comparative Indicator Cards—Obtaining the Clearance From the Indicator Card—Method of Computing the Weight of Steam Consumed Per I.H.P. Per Hour

By T. H. FENNER

HAVING in our last article made some further explanation of the Zeuner diagram, we will in this one show some diagrams with theoretical indicator diagrams drawn from the Zeuners. We should perhaps not call these theoretical diagrams, as they are not constructed quite according to the theoretical law of steam expansion, but rather the diagrams that we should expect to get from a valve with the dimensions of inside and outside lap and the angular advance as shown in the Zeuner diagram.

The first figure is a Zeuner diagram of a valve with normal characteristics cutting off at about three-quarter stroke. It must be remembered that with the ordinary slide valve it is not possible to get cut off very early, in fact not before half stroke, without affecting very greatly the other events. When we wish to get early cut off we have to resort to special means, such as expansion valves on the back of the main valve, special drop cut off valves, such as the Corliss, or the automatic cut off worked by the centrifugal governor.

The four cards here shown afford a means of comparing the effect of different amounts of lap, angular advance, etc., on the steam distribution. Fig. 2 shows the effect of increasing the angle of advance and adding outside lap, and also inside lap. This is done in order to get an early cut off, while keeping the release and compression within reasonable limits and also keeping the lead fairly early. Here we have cut off occurring at half stroke, with release a little earlier than it was in the last card, while compression is earlier, and admission a little earlier. Thus we see again that increasing the angle of advance makes all events earlier. The increased angular advance is not enough of itself to give the cut off where we require it, so the lap is increased. The exhaust lap is practically the same as in the first card, but we might have increased it a little, thus making release a little later and compression a little earlier. This diagram and card illustrate well the reason why a slide valve cannot be made to cut off before half stroke. To make the cut off any earlier with the same angular advance we should have to decrease the lead, while to make the release any later we should have to make the compression much earlier.

Fig. 3 shows the effect on the card of increasing both inside and outside lap, the angular advance being the same as in the first case. It will be seen that the lead is later, while the cut off is earlier. On the exhaust side of the valve release becomes later, while compression is earlier.

Fig. 4 shows the same thing with the laps both decreased. Here we have lead earlier, cut off later, release earlier and compression later. These figures and the preceding ones should have made the reader familiar with the Zeuner diagrams and to some extent with cards. Before going into the question of different forms of valves and valve gears, it would be better to see what other information an indicator card can give us over and above the distribution of steam.

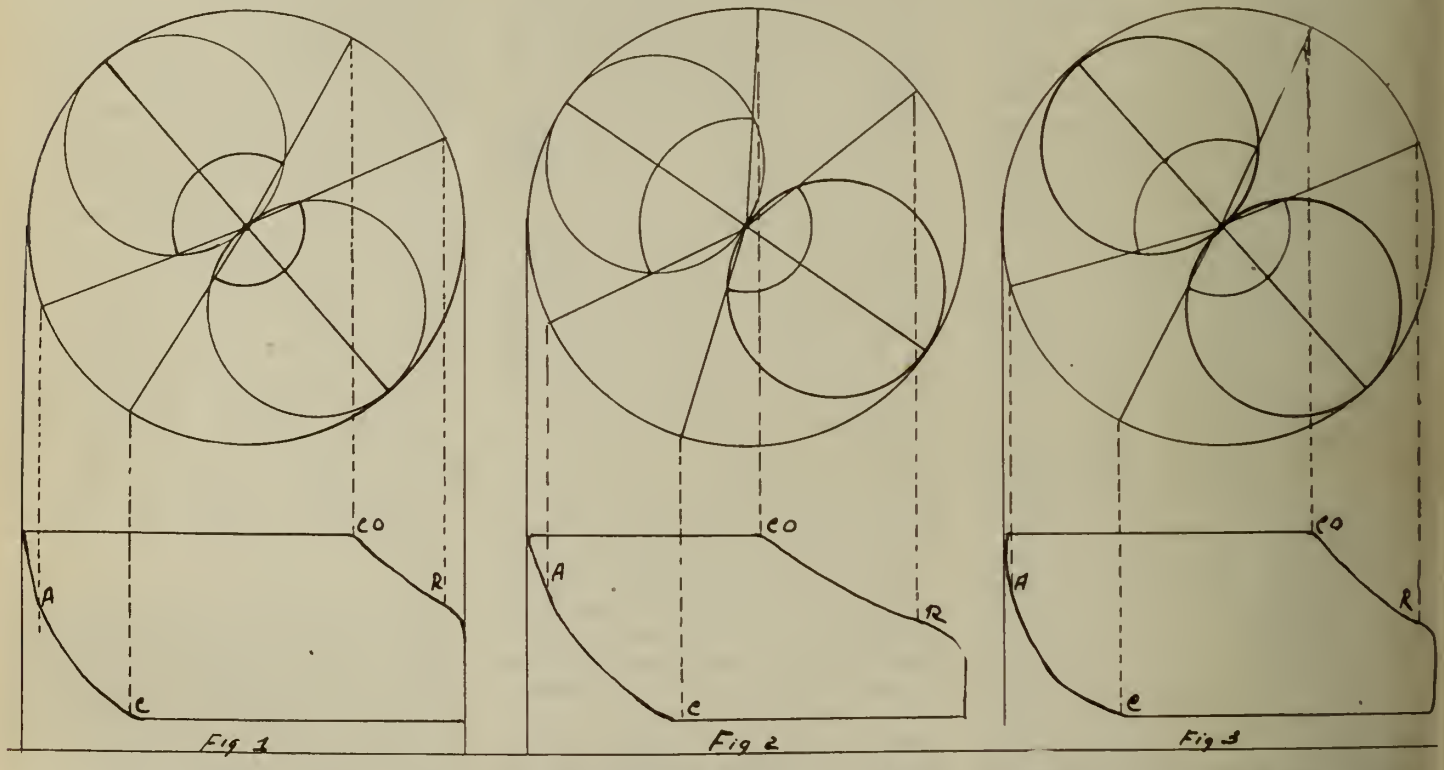


FIG. 1—NORMAL VALVE.

FIG. 2—INCREASING ANGLE OF ADVANCE AND ADDING OUTSIDE LAP.

FIG. 3—INCREASING INSIDE AND OUTSIDE LAP.

Some Uses of Indicator Cards

We have seen that the indicator card can be used to furnish us with the mean effective pressure of the steam in the cylinder, from which we can compute the horse power. From it we can also obtain the weight of steam used per stroke in the cylinder, and from that, of course, obtain the weight of steam per

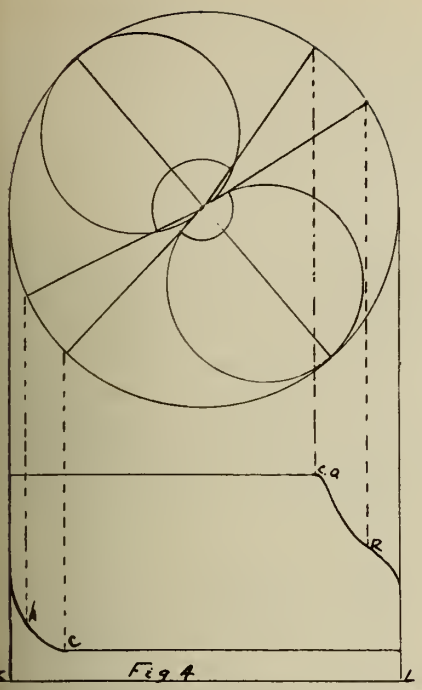


FIG. 4—DECREASING INSIDE AND OUTSIDE LAP.

I.H.P. per hour. We can also compute the amount of clearance, that is, the volume of clearance, and in the case of compound engines, we can see how closely the expansion in the different cylinders approaches the ideal expansion curve which would be made by the expansion of the same amount of steam in one cylinder. From this it will be seen that a good understanding of the indicator card is a great help to those engaged in the operation of a steam engine or steam engines.

Obtaining the Clearance

The clearance obtained from the indicator card is, of course, the clearance volume, and not the linear clearance between the piston and the head of the cylinder. It includes the space from the piston face to the valve face, and is expressed as a percentage of cylinder volume. The effect of the clearance in a cylinder depends on the way it is filled by the steam at every stroke. If the exhaust valve is allowed to close late in the stroke, so that there is practically no steam left in the cylinder, there will be not only a loss of cushioning effect, but the clearance space will have to be filled with fresh steam at every stroke, and this steam will be lost. That is a greater weight of steam will be discharged from the exhaust every stroke than if the exhaust closed in time to give cushioning. The exhaust closing should be arranged so that the compression curve mounts up to meet the admission line smoothly. The steam being compressed by the returning piston brings the moving parts to rest without shock, and besides that fills the clearance space with steam at almost the initial pressure, so that when the valve opens to admit steam just before the commencement of the return stroke, the clearance space is filled with steam at initial pressure. This keeps up the steam line in a horizontal position until cut off takes place, and the clearance space steam is retained in the cylinder.

The effect of the clearance on the expansion line can be shown as follows: Supposing we have a cylinder of 12 inches area and 12 inches stroke or one cubic foot volume. Let the clearance be 10 per cent. of the volume, then the total volume of cylinder and clearance space will be 1.1 cubic feet. If the cut off takes place at 4/10 stroke and the initial gross pressure is 100 lbs. when the pressures for the remainder of the stroke will be found from Boyle's Law, and will be at 5/10 80 lbs., at 6/10 66.6 lbs. and so on, the mean effective pressure being 73.81 gross, and deducting the back pressure, 59.1, assuming atmospheric exhaust pressure. Now if we take into account the clearance we shall have cut off taking place at 5/11 stroke instead of 4/10. This will, of course, affect the expansion line and the mean effective pressure. We shall have at 6/11 a pressure of 83.3, at 7/11 71.4 and so on, the mean effective pressure in this case being 86.81 lbs.

However, this amount of steam that is in the clearance space will be compressed again on the return stroke, so that we will not actually gain anything by it. On the other hand, if it exhausted, we shall have used that much extra steam, and besides that will have lost the good effect of the cushioning, and introduced our admission steam into a cylinder and against a piston that has been so much longer in contact with the exhaust passage, and so we will get a larger amount of initial condensation. Therefore, it will be understood that compression fills a very important part in the good working of an engine.

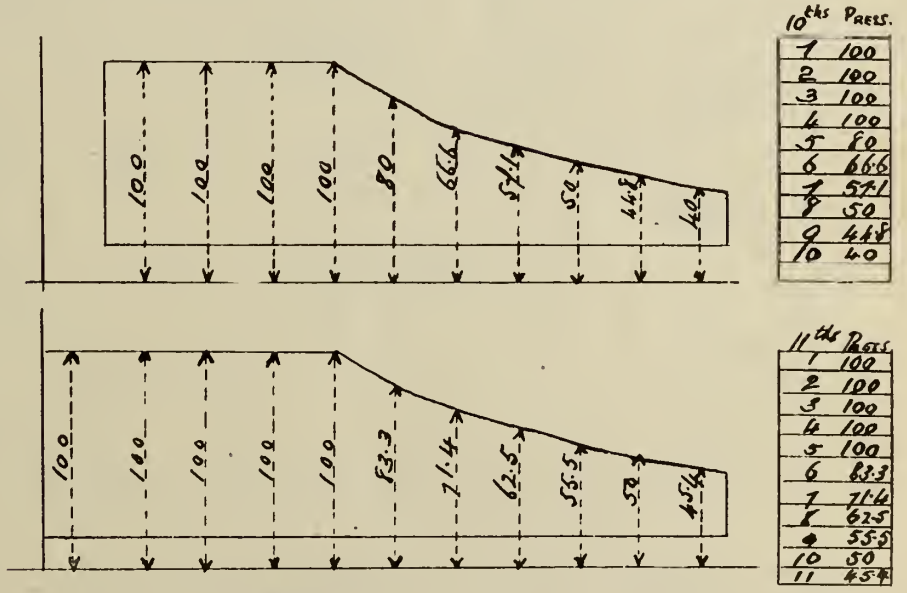
The method of finding the volumetric clearance from an indicator card is as follows. Select two points in the compression curve, and drop perpendiculars from them to the atmospheric line. Take the two points as far apart as possible. Join the two lines by a horizontal line from the lower point to the perpendicular from the upper point and complete the parallellogram. Draw a diagonal to meet the line of absolute vacuum. Where this line cuts the zero line erect a perpendicular, the distance between this perpendicular and the perpendicular dropped from the beginning of the stroke will represent the clearance in the cylinder. The diagrams following show the expansion curve (theoretical) when considering clearance and neglecting it.

Obtaining the Weight of Steam

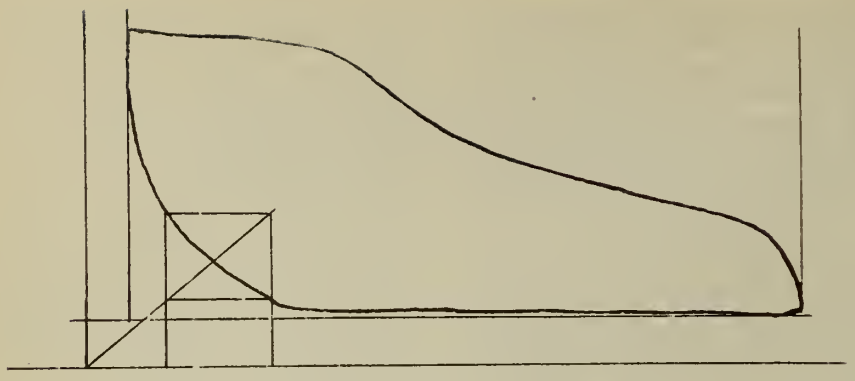
The indicator card being a graphical chart to scale of the pressure and volume of the steam in the cylinder at any moment, it naturally follows that the weight of steam used can be computed from the data furnished by the card.

If we take a point in the expansion curve just before release is effected then we have the volume of the cylinder and clearance up to that point. From the steam tables we can find the weight of a cubic foot of steam at the pressure (absolute) as measured on the card at the point taken. That is the weight of steam in the cylinder at that point, including the clearance steam. We now take another point in the compression curve and find the weight of steam contained in the cylinder at that point. The difference between these two amounts will represent the amount of steam rejected through the exhaust at each stroke. Knowing the horse power developed, we can find the consumption of steam per I.H.P. per hour by a simple calculation.

If the engine is developing 100 H.P. and running 120 strokes per minute, that will be 7,200 strokes per hour. If the consumption is, say, half pound steam per stroke, then there will be 3,600 lbs. steam used per hour, and the horse



M.E.P. WITH AND WITHOUT CLEARANCE.



METHOD OF FINDING CLEARANCE.

power being 100 the steam per I.H.P. per hour is 36 lbs. This can be expressed as a formula:

$$\frac{\text{weight steam per stroke x strokes per hr.}}{\text{I.H.P.}} = \text{steam per I.H.P. per hour}$$

The diagram illustrated herewith shows plainly the method of obtaining the weight of steam per stroke. The line Z Z^1 is the line of no pressure, and the line A L is the atmospheric line. D is the point in the compression curve, and E is the point in the expansion curve. The distance Z O is the clearance space, and O Z^1 is the total length of the stroke. Z Z^1 is the line of no pressure, and the length of the card five inches, which makes it easy to proportion, the clearance space being 10 per cent., we can proceed as follows: Let the initial pressure be 150 lbs. absolute, and the cut off at 4/10 of the stroke. Suppose the diameter of the cylinder to be 36 inches. The absolute pressure at release is 60 lbs. per square inch. The volume of the cylinder and clearance will be

3 x 3 x.7854 x 5 × 1/10 (3x3.7854x5)
=35.34 + 3.534= 38.874

The volume of steam contained in cylinder and clearance space at release will be

38.374 x 10/11=34.885 cubic feet.

The weight of a cubic foot of steam at an absolute pressure of 60 lbs. per square inch is .1394 lbs., so we have

34.885 x .1394 = 4.862 lbs.

If there were no compression this would be the consumption per stroke, but we have to deduct the volume of steam contained in the cylinder after the exhaust valve closes. From our point in the compression curve we find the volume of the cylinder and clearance at that point. This is practically 14 of the total volume, so we have

38.374 x .14 = 5.37 cubic feet

and using the factor for the weight per cubic feet we again get

38.374 x .14 = 5.37 cubic feet,

Deducting .748 lbs. from 4.862 lbs. we have 4.114 lbs. per stroke.

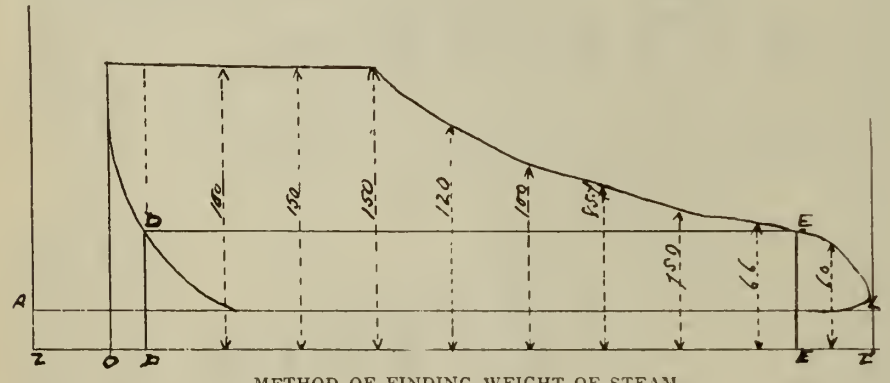
Suppose now that the engine is making 60 revolutions per minute, or 120 strokes. This will be 120 x 60 = 7,200 per hour. The weight of steam consumed will be

7,200 x 4.114 = 29,620.8 lbs. per hour.

The mean effective pressure measured on the card will be 110.73 — 14.7 = 96.03.

The I.H.P. will be

$$\frac{96.03 \times 36 \times 36 \times .7854 \times 5 \times 120}{33{,}000}$$



METHOD OF FINDING WEIGHT OF STEAM.

=1777.25 I.H.P.

The steam consumption per I.H.P. per hour would be

$$\frac{29{,}620}{1777.25} = 16.6 \text{ lbs.}$$

It will be understood by the reader that no such results as this would be obtained from an actual card, and one would hardly meet with just such an engine. The example is only chosen as an illustration, and serves to show the method employed.

Steam consumption from indicator cards cannot be depended on within less than 2 to 3 per cent. of an error. The only absolutely correct way to get at steam consumption is to weigh the water of condensation, or use a flow meter.

COUNCIL REFUSES INCREASE

The Saskatoon council at a recent meeting refused to grant any increases to the electrical men in the city power station, after a long discussion with a delegation representing the men. The men claimed that as the station was now on a paying basis, they were entitled to a fair wage, which they were not receiving, they asserted, when compared to other places in Western Canada. The council took the view that the city's finances were in such a state that it was impossible to grant any increases or to enter into any further liabilities. The question was put to the men by Alderman Blain as to whether they would prefer a cheque for $100 that would be honored or one for $150 which would come back marked N.S.F.

Plans are being prepared for a workshop costing $60,000 for the city of Ottawa. Tenders will be called shortly.

* * *

The Winnipeg Supply & Fuel Company, 405 Canada Building, are planning the erection of a warehouse at cost or $60,000.

* * *

The Gove Motor Car Company, Tilbury, Ont., are contemplating construcethe erection of a warehouse at cost of $50,000.

* * *

Work will be started in the near future on the erection of a foundry for the National Castings, Limited, Belleville, Ont.

* * *

An athletic stadium is to be erected on the corner of King Edward Avenue and York Street, Ottawa, at a cost of $350,000.

* * *

The Southern Ontario Gas Company have announced recently that they are planning to erect a large artificial gas plant at Dutton, Ont.

* * *

The McIlroy Belting & Hose Company, Hammond, Ind., are opening up a branch office at Kingsville, Ont., and will instal equipment to cost about $20,000.

* * *

Bought Leaside Plant.—The Leaside Munitions Company, Limited, have completed the purchase from the United States Government of the large plant erected at Leaside during the latter months of the war. This plant was built for the American Government by the Leaside Munitions Company for the manufacture of twelve-inch shells for the United States artillery, but the plant and its equipment had only been completed a few days when the armistice was signed, with the result that it was never put to its intended use. It will be used by the present purchasers for manufacturing purposes.

Erecting and Lining Up Steam Engines

Adjusting the Main Bearings—Fitting in the Piston—Various Types of Crossheads—Getting the Shoes Adjusted—Finding the Correct Length of Connecting Rod

By "FITTER"

AFTER the shaft has been tested for alignment with the cylinder and found correct, the main bearing side pieces and caps are put on. Most engines for heavy duty have the main bearings made in four parts, and the side pieces are adjusted by means of wedges and studs, the caps being held in the usual way by a heavy cast iron bearing cap. The best way to adjust the top quarter is by means of taking leads from bearing and fitting shims under the cap to give just the requisite pressure when the nuts are tightened up. The side pieces or quarters are adjusted by pulling up on the nuts until they are just comfortably tight by hand, when they can be further tightened up by a short spanner, the amount of weight to be put on the spanner being a matter of judgment. Probably the best way to adjust the side pieces is to pull them up by means of a short lever placed under the nut, and then run the nut down tight by hand, and leave the final adjustment till the engine is running. This allows one to feel by the action of the studs just when the quarter piece is tight, as when there is any slack a jumping action will be felt on the studs, which will gradually disappear as the wedge tightens up. The back pieces should be fixed first and the front one brought up, to suit. However in the erecting shop the quarter pieces can be adjusted by tightening up, and the crank shaft tested again by the line when everything is tightened up. It is quite possible to throw the shaft out of line by tightening the outboard bearing up more than the inner one, or vice versa, but in order to do this it would be necessary to put some weight on the spanner with which the adjusting nuts are tightened up.

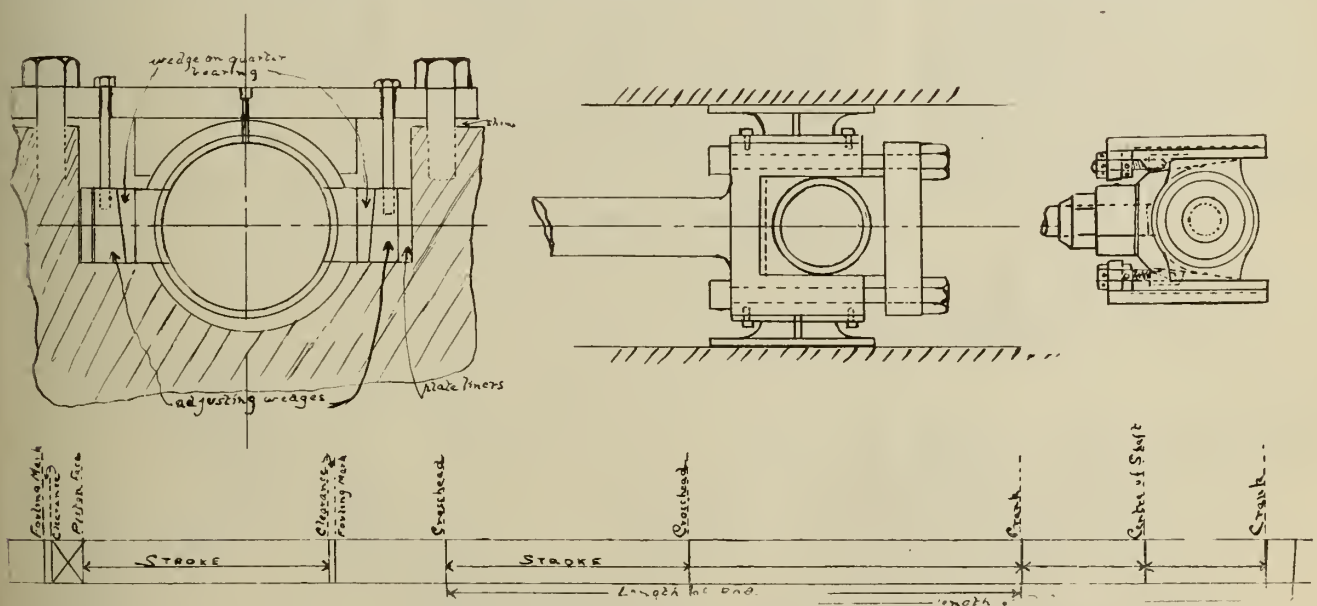
To fit the top quarter three pieces of lead wire are laid on the shaft, and the brass put down on these, the cap, being then put on and tightened up. The nuts are then removed, the cap and brass lifted again, and the leads examined and gauged for thickness. They should be about 28 to 30 gauge, and if they are any finer than that, shims should be put under the lugs of the cap in order to relieve them, and allow the nuts to be tightened down properly. It is a mistake to allow bearing caps to run loose because the nuts cannot be tightened up without heating up the bearing.

The various parts of the bearings, consisting of the four bearing quarters, the wedges, quarter plates, etc., should be all typed with numbers corresponding at their edges, so that they can be put back in their right place when the engine has to be re-erected. Letters or numbers can be used, so long as a definite scheme is adopted and adhered to right through. Most engine builders adopt the plan of using the order number of the job and the part number on each piece.

Having got the crank shaft properly in place and the bearings adjusted and tightened up, and the shaft checked up for alignment, the line can now be removed, and the piston and rod put in place. The piston rod may be made with the crosshead as part of the rod, or it may be made and usually is in stationary engines with the piston rod end screwed for the reception of the crosshead. Naturally it will make a great difference which way the rod is made as to the way it is put into the engine. If made with a solid end, the rod must be passed into the cylinder through the stuffing box, and the piston placed on last, or the rod will be passed through the cylinder from the cover end, with the piston already assembled to a certain extent, and the crosshead screwed on after.

The amount of assembling on the rod that the piston will have had in the latter case will depend upon the form of the piston packing. If piston is furnished with Ramsbottom rings, the rings will be in place when the piston is put on the rod, while if the construction is a built up one, the rings will be assembled on the piston after it is placed in the cylinder, and the junk ring or follower placed last.

The form of the crosshead will also make a difference in the method of erecting. If the crosshead forms part of the piston rod, then the piston rod must be centred in the guides, and gauges made for the distance of the slippers from the crosshead faces to the guide faces. If the crosshead is of the screwed on type, and the guides are bored for circular shoes, the shoes will be most likely fastened to the crosshead in such a way that they can be adjusted by means of



MAIN BEARING ARRANGEMENT—SOLID TYPE CROSSHEAD—CROSSHEAD WITH WEDGE SLIPPERS—STAFF FOR GETTING CONNECTING ROD LENGTH.

a stud, which draws them further on the crosshead or pushes them further out, at the same time making them wider or narrower relatively to the guide faces.

We shall review these operations in a little more detail. Suppose that we take the piston with the Ramsbottom rings, and a piston rod fitted with a screwed crosshead, which is by far the most usual type to be met with in horizontal stationary engines, and in many vertical ones also. The guides on vertical engines are, however, not made circular. The first job is to pick up the piston and rod, the piston being fitted onto the rod but without the rings being in their place. The rings will have been finished and cut to the right length and fitted in the cylinder before the cylinder came into the erecting shop, but it is usually a safe thing to try them in and see that they are not too long before placing the piston. Placing the rings on the piston if they are of usual Ramsbottom type is a simple matter, the only thing required being care. There will be three rings as a rule, and by placing the bottom one on first before the piston is taken to the cylinder, there is only one ring the middle one, that has to be passed over a groove before reaching its own. In order to do this a few pieces of thin tin are placed over the first groove at different parts of the circumference so that the ring will not slip into it while being passed over. The ring is placed on the piston, and pushed down slowly and evenly till it reaches its place. Putting on a big piston ring is no different to putting on a 4-inch piston ring, the only thing necessary being care and patience.

If the piston is of the built up variety the ring may be one single broad ring or it may be a sectional ring with a spring to each section. In any case the piston is entered first and the ring put on after.

The Ramsbottom rings having been fitted, we are now ready to enter the piston and rod in the cylinder. In order that we may not damage the screwed end of the rod while passing it through the neck bush of the stuffing box, it is better to land the piston and rod on blocking at the cylinder end, so placed that the piston is just at the mouth of the cylinder while the end of the rod is not quite up to the neck bush. The piston should be entered into cylinder by edging it gently along with a bar and at the same time a man at the stuffing box end should try and guide the rod end so that it does come fair with the cylinder neck bush. It may be necessary to see that the rings do not enter the steam ports and if this is the case, strips of sheet iron are placed across the piston rings and ports so that the rings are kept down until they have passed the danger zone. Here again ordinary care is needed in entering the piston and rings, and if anything seems tight, a careful investigation should be made before any rough tactics are resorted to, or patience is lost. This warning may seem superfluous, but in the writer's experience several cases of damage have been done by the too hasty application of a big bar or an impatient blow with a hammer.

When the rings are safely entered, and the rod end is also safely passing through the stuffing box, with no threads burred up, the rod should be shoved through until it is half way along the guides, that is, the piston is about in the centre of the cylinder. The rod should now be centred in the guides, and this can be done by callipering from the centre which will be in the end of the rod to the top and bottom of the guides. This distance can be checked up after the rod is found to be central with the distance given in the drawing, and once the rod is correctly set, it should be blocked top and bottom. When dead central in the guides, it should also be absolutely horizontal, so that the spirit level here gives another check. The crosshead jam nut should now be run on the rod, and the crosshead without the shoes screwed onto the rod. It should be run on the rod until the rod end shows through the crosshead just flush, and the nut run down till it just touches the crosshead. The bottom shoe should now be put on and adjusted until it is just supporting the rod. The top shoe can now be put in place and the rod callipered, and the shoes adjusted if necessary until the rod is dead central in the guides. The adjustment is easily made by the wedge shaped formation of the shoe and crosshead, and the adjusting screws.

If the crosshead had been of the solid type, we should have had to proceed in somewhat different manner. The piston rod would have been entered through the stuffing box and the piston put on the tapered end and the nut tightened up, after which the rings would have to be fitted. The rod would then be blocked up central in the guides, which would have been flat instead of bored out, and gauges made for the width of the crosshead slippers. This type of crosshead is more met with in marine and vertical stationary engines than in the ordinary horizontal Corliss type.

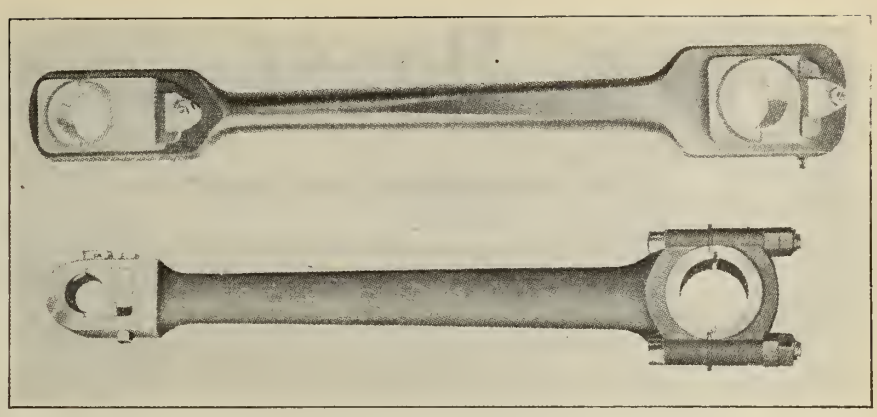
After the gauges had been made, the shoes would have to be put on the planer and machined down to the required width. In this type of crosshead the wear is taken up by liners while in the type we first dealt with the shoes are adjustable on the crosshead in a very easy way. Making the gauges is a fairly simple matter. After the crosshead is centred, pieces of 1-16th flat iron are taken and carefully fitted in between the crosshead and the guide face, being filed down as necessary until they are a nice sliding fit. The gauges are then passed on to the machinist who then marks off the crosshead shoe to correspond with the width of the gauge.

Getting the Connecting Rod Length

After the piston rod and crosshead are assembled, and the guide shoes fitted, the next job will be to put the connecting rod in place. Before this is done, the length must be checked up on the job. That is the length between centre and centre of crosshead and crank pin. The connecting rod may be made with box ends in the marine style, or the bottom end, usually called the big end in stationary work may be of the box type, while the small end is of the gib, strap and cotter type. In any case, it is usual to make a staff showing the exact distance from crosshead pin to crank pin when the piston is at each end of its stroke. It is obvious of course that in an arrangement where the crosshead is screwed onto the piston rod, there is ample room for adjustment, while in a solid crosshead arrangement any discrepancy in the length would have to be made up with liners, or if too long, by planing off the foot of the rod.

A staff is made long enough to cover the whole length of the engine and first of all the cylinder length is marked on it from cover to cover. This can be obtained without much trouble. A line is marked on the staff representing the cylinder face, and then the distance the cover projects into the cylinder is marked away from the first line. That is the fouling mark at the head end. The piston is then pushed down the cylinder until it strikes the end of the cylinder, and the distance it measures from the cover taken. This distance plus the thickness of the piston which is of course known gives the fouling mark at the opposite end of the cylinder. The staff is now laid down alongside the engine, and the line corresponding to the cylinder face placed just flush with the end of the cylinder, by means of a straightedge laid across it. By dropping a plumb bob down across the centre of the crank shaft, and squaring across from the bob, the centre of the shaft can be transferred to the shaft. Lay off on each side of this centre mark the length of the crank, and you have the two dead centres of the crank pin centre. Assuming that the crosshead is screwed up on the piston rod so that the rod just comes flush, there will be several threads left for adjustment. If the piston is now pushed hard up against the front head of the cylinder, and the centre line of the crosshead pin measured on the staff the exact length of the rod from piston to crosshead centre will be obtained. Now mark on the staff at each end the amount of linear clearance of the piston from the cylinder heads, remembering that as the engine wears the piston will approach the front so that there should be a little more clearance at the front head than the back. Suppose that the clearance at the head end is 1-8th and the front 3-16ths. Mark these clearances on the staff, by lines at these distances from the fouling marks. Now it will be plain to see that if we lay off the length of the piston and rod to the centre of crosshead pin, the distance from the clearance mark to the crank pin dead centre will be the length of the connect-

ing rod centres. This distance measured from the outer dead centre of the crank pin should give the right clearance on the front end of the cylinder, but if it does not, the crosshead may be adjusted either in or out on the rod just half the necessary amount, till the clearances are correct at each end. With a solid crosshead the discrepancy would have to be taken up on the centres of the connecting rod, and therefore the rod is never made up until the length has been secured from the engine in the manner just described. The accompanying diagrams will make the points mentioned in this article easy to follow.



TYPES OF CONNECTING RODS.

A 1,000,000 HORSE-POWER HYDRO DEVELOPMENT

THE water level of Montreal is now about 24 feet above the sea-level, and ocean going steamers reach Montreal without using any locks. Lake St. Louis is about elevation 76.

My project is to build a dam in the Lachine Rapids at Isle Heron, holding the water to the Lake St. Louis level. By putting locks on the north side of the river, ocean vessels will then be able to reach Lake St. Louis. But in order to reach the locks, it will be necessary to dredge a channel as wide, as the St. Lawence River at Montreal, up to this dam.

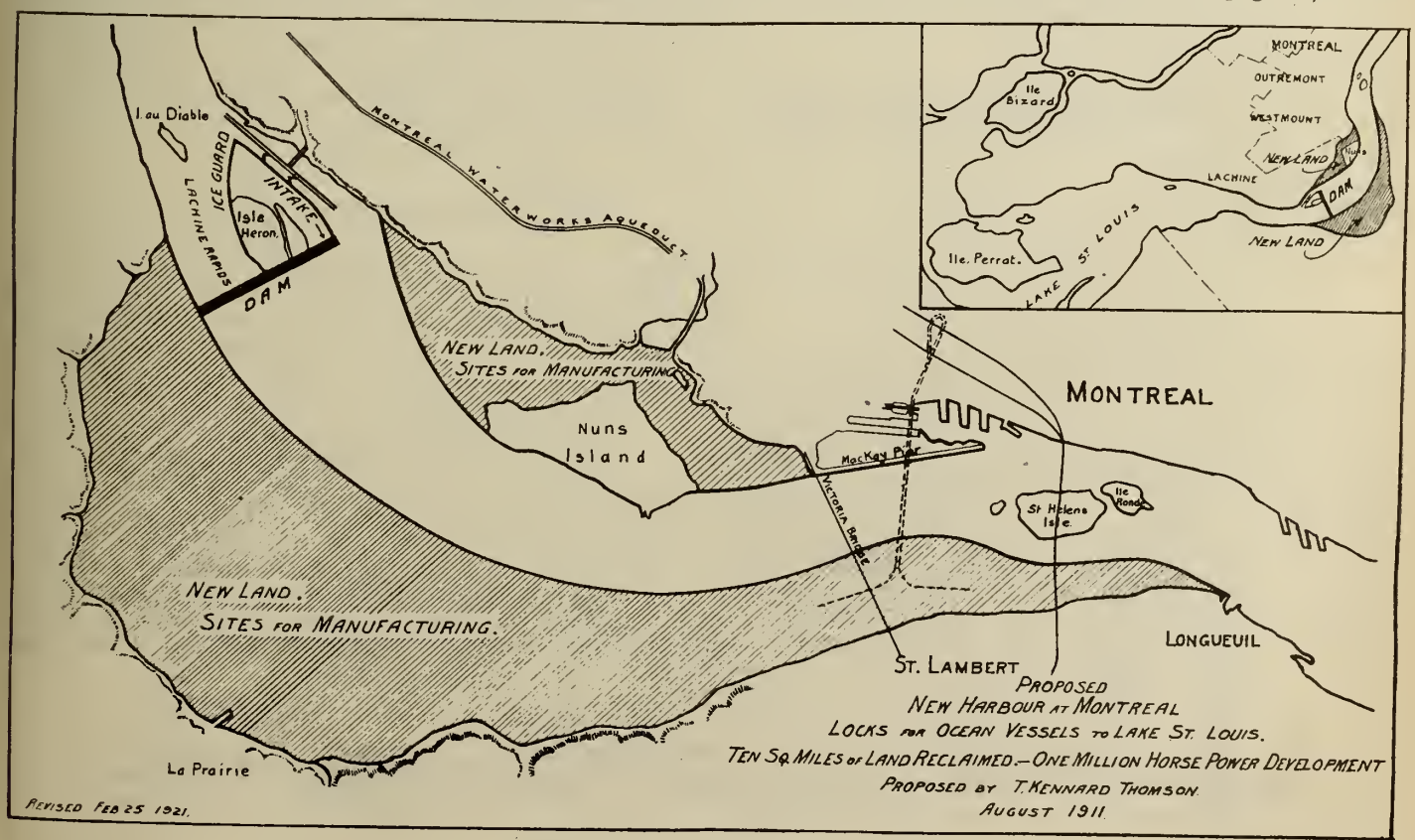
By doing this we could reclaim ten square miles from the bay or wide part of the river between Montreal and Lachine. This bay or widened river has been responsible in the past for the accumulation of frazil and other ice and frequent floods in the lower part of Montreal. The land thus reclaimed would afford Montreal a badly needed manufacturing site and would be connected with the city by ample tunnels. This project, the late Sir William Van Horne stated shortly before he died, would make Montreal one of the greatest ports in the world. Especially as the dam would enable us to develop one million horsepower a year, or the equivalent of ten million tons of coal a year.

This project should be of vital interest to the city of Toronto, or as a matter of fact the whole of Canada. First, because it would insure the early canalization of the St. Lawrence River, permitting vessels of 30-foot draft to reach the Great Lakes. It would also be of vital importance to the whole Province, as it would also enormously decrease the cost of many manufactured articles, just as the five Pioneer Companies at Niagara Falls practically made aluminum and other articles accessible to the great mass of people by enormously decreasing the cost of manufacturing them.

A former president of the New York Central Railroad once stated to me that people thought that the New York Central Railroad was opposed to the Panama Canal, which objection he said would be most stupid. For the building of the Panama Canal could not but help build up the entire Pacific Coast, and that anything which built up the Pacific Coast would enormously increase the business of the Transcontinental Railroads. He might also have added that it would benefit the entire continent by reducing the cost of handling commodities.

It seems a crime that there should be any delay whatever of the development of these two rivers. At the same time,

(Continued on page 32)



PLAN OF 1,000,000 H.P. DEVELOPMENT.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

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Women in Engineering

ONE of the results of the war was to introduce women into fields of endeavor that had been formerly strictly a preserve of the sterner sex. Now that the war is over, and in places peace has settled down, women show signs of wishing to keep up the work that they learned so well during the strenuous days of the war. In this connection the Women's Engineering Society, an institution formed in England during the war, in casting about for a means of utilizing the services of women who were trained in engineering, have formed a company known as the Atalanta Company, Ltd., in which the whole staff executive and works, and all the labour is of the weaker, or as Kipling would say, the deadlier sex. The works have already secured several contracts, including the making of glass machinery, atomisers, etc. The capital is entirely put up by women, and the Board of Directors includes Lady Parsons, Miss Caroline Heslett, who is secretary of the Women's Engineering Society, and Lady Shelley-Rolls. This is a long step ahead for the ladies, and if they make a success of it without any assistance from the more experienced male engineers and business men, they will have a lot to be proud of. We are, however, very doubtful of the success of such an enterprise if wholly managed by women, and our suspicions are justified by the fact that in the Board of Directors there appears at least one man, who is a principal of a technical college. This looks as though the ladies were not above accepting some advice now and again. There is no doubt that during the war women gave of their service unstintingly, and were deserving of great praise, but we believe that now is the time for them to retire gracefully into their various pre-war spheres. We believe with all respect to the fair sex, that there are other pursuits more suited to their abilities than that of engineering. We shall watch the progress of the experiment with interest.

Another Power Proposal

WE have illustrated in another part of this paper a further water power development suggested by Mr. Kennard Thompson, the Canadian engineer who recently described his plans for damming the Niagara River, and tunnelling Goat Island, in order to procure some 4,000,000 H.P. The plan discussed in this issue is to be carried out further down the St. Lawrence, near Montreal. Here the author proposes to erect a dam to utilise further the 50 feet of fall available at Lachine Rapids and to do so without interfering with the navigation of the St. Lawrence in any way. In dredging a channel to approach the locks that would be built in order that steamers could reach Lake St. Louis, some ten miles square of land would be reclaimed, which could be used for industrial purposes. Hence a great manufacturing district would be induced, supplied with cheap and abundant power. The estimated power would be 1,000,000 horse. It is of course impossible to pass an opinion on such plans as this and the Niagara River project without the very fullest information, but there is a breadth of vision and a confidence of success about these proposals which commend themselves to our opinion. We believe that this is the way to go about developing the vast powers that we have so that they will benefit the country at large.

The Perpetual Air Compressor

WE were somewhat disappointed this week at not receiving a host of letters from our readers pointing out where the inventor of the air compressor described in our last issue had gone astray. To any engineer in a power plant where there are reciprocating engines, the mistake made by this deluded Grecian gentleman should be obvious. Any man who possesses a first or second class certificate of competency as a stationary engineer in Ontario should be able to prove by a simple calculation that the claims of the invention are based on a wrong impression. The very first figures given by the inventor as to the number of foot pounds required to compress one cubic foot of air to a pressure of 10 atmospheres are quite wrong, and show that he has no grasp of the subject that he claims to know all about. Surely he cannot get away with such wild statements before an audience of stationary engineers such as the readers of Power House.

Progress in New Equipment

PRODUCTO COMBUSTION GUIDE

The Producto Combustion Guide, which is a recent development of the Progress Products Company, 1313 Race street, Philadelphia, Pa., claims to make it possible to eliminate the costly waste caused by excess air by pointing out at a glance improper combustion conditions such as too thin a fire or holes in fire. The Guide also reports conditions where too thick fires or clinkers are causing losses due to incomplete combustion.

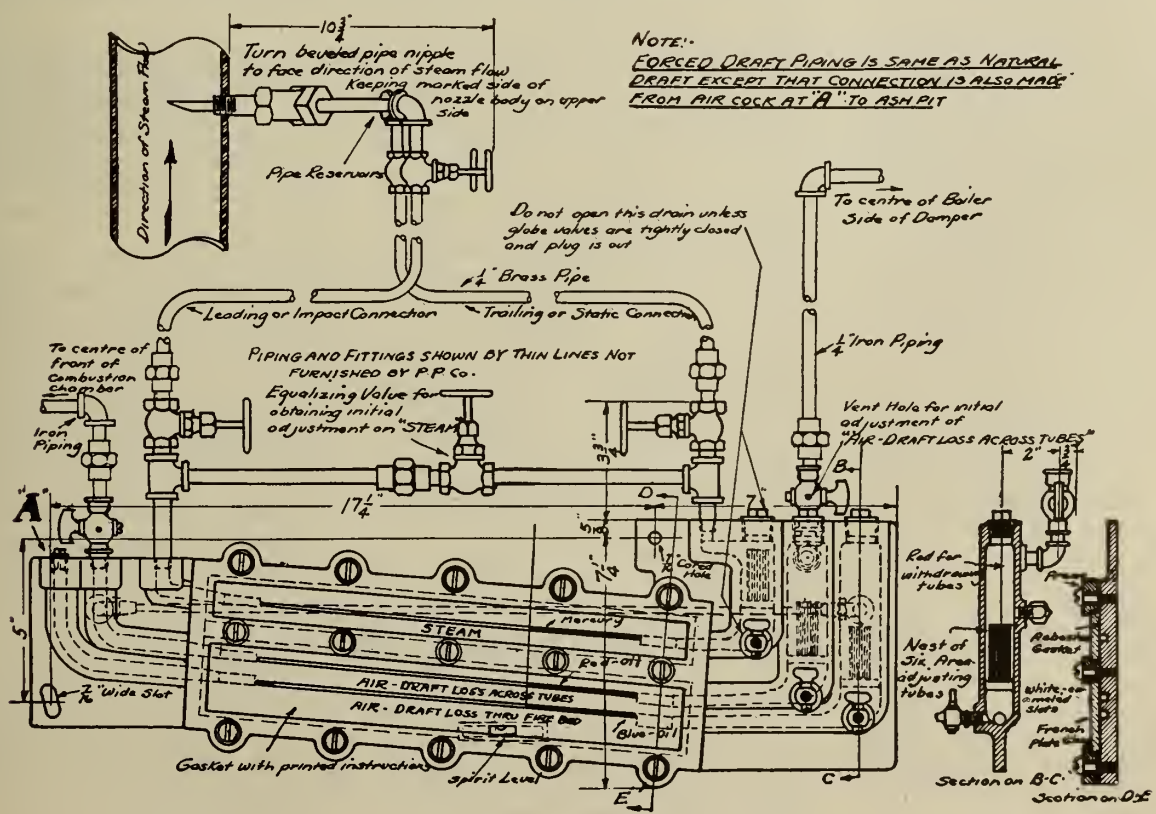
Since the instrument not only tells when conditions are not ideal, but also reports what to do in boiler operation, the fireman is guided every minute of the day in the setting of the dampers and the control of the fire. Other inefficient firing conditions, such as excessive soot on tubes, broken baffles and leaky settings are also pointed out definitely as soon as they begin to develop. The power loss due to these causes is the greatest part of the preventable power loss and totals about 25 per cent. in the average plant.

Pressure differences, due to both steam and air flow, vary as the square root of the velocity. The other factors involved, although different, are constant for a given condition, and the differences are compensated for in the instrument by three nests of variable adjusting tubes, which, by controlling the areas in the liquid reservoir and consequently the relative movement of the different liquid levels, make the alignment a simple proposition. The liquid level in the upper tube moves in proportion to the steam flow; those in the lower tubes in proportion to either the quantity of air flow or to the change in resistance to flow either through the boiler tube or the fire bed.

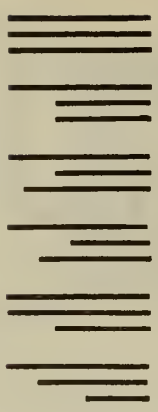
By means of these adjusting tubes the movements of the indicating liquid columns are equalized when the boiler on which the instrument is being installed is operating efficiently. Thereafter for good operation these levels should be in line. Different out-of-alignment combinations indicate different inefficient furnace conditions which can be remedied immediately by the fireman controlling the fire, air supply, etc., so that the alignment is restored. This instrument combines the advantages of a steam flow meter and multiple differential draft gage with a tell-tale idea.

The body is cast iron and the indicating tubes which are usually found in instruments embodying the idea of inclined liquid passages have been replaced by machined slots in the cast iron, which are covered by special Safetee glass. The slots in which the liquids travel are white porcelained, so that the levels are plainly visible. The special gasket used has printed upon it instructions in the use of the instrument, including diagrams of the liquid level combinations when improper conditions are prevailing.

The combustion guide is made in two standard types which will meet all existing boiler room conditions—natural draft type and forced draft type. The forced draft type has the same liquid passages as the natural draft, and an additional non-adjustable one, which, being really a draft gage, gives the pressure conditions over the fire in inches of water. The steam passage contains mercury and the air passages colored oil. The steam indication is actuated by the difference between leading and trailing pressures transmitted to the mercury


Turn beveled pipe nipple to face direction of steam flow Keeping marked side of nozzle body on upper side
Direction of Steam Flow
Pipe Reservoir
NOTE:- FORCED DRAFT PIPING IS SAME AS NATURAL DRAFT EXCEPT THAT CONNECTION IS ALSO MADE FROM AIR COCK AT "A" TO ASH PIT
Do not open this drain unless globe valves are tightly closed and plug is out
To centre of Boiler Side of Damper
¼" Brass Pipe
Leading or Impact Connection
Trailing or Static Connection
¼" Iron Piping
To centre of front of Combustion Chamber
PIPING AND FITTINGS SHOWN BY THIN LINES NOT FURNISHED BY P.P. Co.
Equalizing Valve for obtaining initial adjustment on "STEAM"
Iron Piping
Vent Hole for initial adjustment of "AIR-DRAFT LOSS ACROSS TUBES"
17¼"
STEAM
Mercury
Red Oil
AIR - DRAFT LOSS ACROSS TUBES
AIR - DRAFT LOSS THRU FIRE BED
Blue Oil
Red for withdrawn tubes
Nest of Six Areas adjusting tubes
Asbestos Gasket
White porcelained slots
French Plate
Gasket with printed instructions
Spirit Level
Section on B-C
Section on D-E

THE PRODUCTO COMBUSTION GUIDE.



Air supply correct—fire and boiler in good condition.

Excess air—
Fire and boiler in good condition.

Holes in fire permitting air to get through unused—Steam low.

Excessive soot has increased friction through tubes and lowered steam.

Fire too thick or clinkers are interfering with passage of air through firebed.

Correct air supply—fire O. K.
Baffle broken—gases short circuiting.

HOW IT WORKS.

from the nozzle plug or orifice plate furnished with the instrument.

BREAKDOWN OF A TURBO ALTERNATOR

The following letter from the Metropolitan Vickers Electrical Co., Ltd., England, to the "Engineer" contains an interesting account of a breakdown somewhat unusual in its nature, and the means adopted to correct the liability to a similar recurrence:

On the morning of December 8 one of the new 15,000 K.W. turbo-alternators at Dalmarnock Station, Glasgow, broke down after being in commercial operation for about two and a half months. The insulation on the windings at one end of the machine took fire and as the machine could not be stopped for some twenty minutes, the whole of the insulation on this end of the machine was destroyed.

No evidence could be found at the time as to the cause of the breakdown. The machine was very heavily insulated and every precaution had been taken with regard to winding and testing. As another generator was almost ready for service, it was substituted for the first machine, and, although the breakdown occurred on Wednesday morning, the new machine was in position, tried out, and put on load the following Wednesday.

After operating on commercial load for about a week sparks were seen issuing from the top of the stator frame, and the machine was shut down. The windings were found to be in perfect condition, and the machine was run up again with field on, when sparks were again noticed, and further examination showed that one of the insulated bolts through the core had broken down near the endplate. These bolts pass through the core in an axial direction, and serve to hold the endplates tightly against the laminations. The bolt was removed, and it was found that it had vibrated violently and the insulation had broken down near the centre of the core as well as near one end. The windings were found to be in perfect condition, but an inspection of other bolts which had not given trouble showed that vibration of a more or less serious nature had occurred on several of them.

A series of tests and investigation was at once undertaken, and it was found that for the particular length and diameter of bolt used a relatively slight tension was sufficient to bring the frequency of the bolts to such a value as to synchronize with the frequency of vibration of the whole set, corresponding to the speed of 1,500 revolutions per minute. A further and more careful inspection of the first machine which had broken down showed that the breakdown was due to a similar trouble, as it was found that one of the bolts had broken down to the core, and molten metal had come into contact with the insulation at one end of the machine, thus setting it on fire.

A third generator was practically ready for running at the time the first breakdown occurred, and it was decided to remove the steel core bolts and replace them with copper bolts of smaller diameter which would carry heavier insulation. These bolts are stressed to such a low value as to leave their natural frequency very far below the running frequency of the machine. A considerable amount of work was required in order to replace the bolts, but this was done in an exceptionally short time, and before the end of the month the work had been completed and the machine was under load. Since this time it has carried peak loads up to 21,000 kilowatts. The two machines which broke down are being rewound, and will shortly be in commission.

The use of core bolts has been standard practice on the part of many companies in this country, America, and on the Continent. Machines have been in operation for fifteen years in which this construction has been used, and the Westinghouse Company of America has a very large number of machines in operation in which the same construction is used. This is the first case on record where trouble has resulted due to the use of the core bolts, and it is very remarkable that it should have occurred on two machines in such rapid succession, though the fact that they are duplicates and built by the same workmen may explain this.

The trouble was due to the fact that a peculiar combination of conditions resulted in the bolt having a frequency equal to that of the machine, and vibration once having been set up, the insulation on the bolts was more or less rapidly disintegrated.

While the Metropolitan-Vickers Company assumes full responsibility for the trouble which has occurred, the following points might be emphasized:

1. The insulation on the windings of the machines has been in no way responsible for the breakdowns.

2. The voltage between the bolts and core was approximately 100, and while the damage was due finally to the breakdown of the insulation on the bolt, the cause of the breakdown was purely mechanical.

3. The construction which was responsible for the trouble is not a new or experimental one, the breakdowns being due to a particular combination of conditions the existence of which could not reasonably have been anticipated.

We have received a bulletin published by the Neptunus Ship Supply Co., Inc., describing and illustrating the Erfmann boiler water controller. This little apparatus has been devised to provide a means of determining the amount of soda water necessary to be fed to the boiler with the feed water in order to neutralize the scale-forming and acid-making constituents. It consists of a small case with two graduated vessels, and two bottles containing the necessary chemicals to produce the reaction from the sample of feed water taken. Ample directions are given for testing the boiler water, which is drawn off into one of the graduated vessels, and the amount of soda necessary is read direct from a graduated scale on the testing vessel. The firm's address is 73 Front street, New York City.

A 1,000,000 HORSE-POWER HYDRO DEVELOPMENT

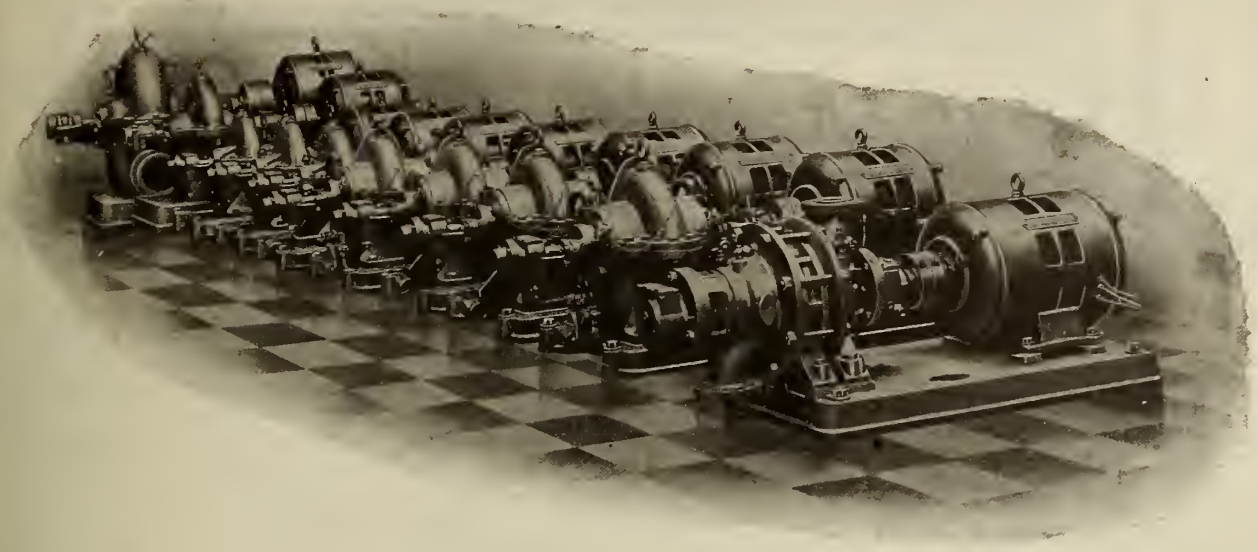
(Continued from page 29)

care should be taken that they are developed the right way, and that no gross monumental blunder be made at that time.

This reminds me of a story told me by a minister in Toronto some forty-five years ago, which illustrated his point, that if one could not do a thing in the right way, it would often be better not to do it at all. He did this by citing a case of a man who fell off the Yonge street dock the preceding week. A spectator rushed up and down yelling "Save him! Save him! Why doesn't somebody save him!" And as nobody seemed to be doing anything, he thought that he would have to do it himself. So he seized a log of wood and threw it to the man in the water, thereby knocking his brains out.

This work can be done so as to pay enormous taxes in addition to the great benefits of cheap power, transportation, etc., or it can be done for great outlays of public money which will never be returned.

Which shall it be?



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The Operators' Point of View

DIESEL V. SEMI-DIESEL

AS an old subscriber of more than ten years' standing I would like to make a few remarks regarding an article in the Power House issue of February 20, 1921, by F. A. McLean, of the Canadian Ingersoll Rand Co., and in which I was very much interested, as I am a Diesel oil engineer myself, and I beg to differ with him on some points.

In paragraph two of the article he mentions the poor flexibility, in starting and stopping, of a Diesel engine. This point is not quite clear to me, as a Diesel engine can be started from cold, and be put on full load within two minutes after entering the engine room, and can be stopped by closing off fuel and injection air.

Mr. McLean also makes the same mistake as many other engineers in regard to the high compression pressures and temperatures of the Diesel engine cycle. That is, that they are much higher than those prevailing in oil and gas engines of the low compression type, and with the consequent inability of the metals to withstand the severe service.

Now this is incorrect. The compression pressure, it is true, is higher, viz., 475 to 500 lbs. per sq. inch, with corresponding temperatures of 950° to 1,000° F. scale, and I may say these are about the maximum, whereas the temperature of the exhaust of gas engines is often considerably more than twice this working on the constant volume cycle.

Take the case of an engine working with a compression of 103.8 lbs. per sq. inch absolute and the explosive mixture to be one part gas to seven of air, and that the heat of the combustion of the gas is 640 B.T.U. per cu. foot. The temperature at the end of explosion would be 5.568° absolute or 5107° F, while the temperature of the exhaust would be about 2600° F. and the pressure at its maximum would reach 628.6 lbs. per sq. in. absolute, say, 614 lbs. gauge, and which would come on the piston almost as a dead blow, while the 475 to 500 lbs. per sq. in. would come gradual on the piston of a Diesel engine.

He also speaks of air injection pressures as if 1,000 lbs. per sq. in. were common. In actual working the pressures vary according to the load. No load, 520 lbs.; ¼ load, 570 lbs.; ½ load, 640 lbs.; ¾ load, 710 lbs.; full load to 10 per cent. overload, 780 to 920 lbs. per sq. in., and the compressor is part of the engine, and does not affect the B.H.P., but the engine would be 6 per cent. more efficient were it not necessary, and, in fact, some Diesel engines have solid injection instead of air.

Regarding the efficiency of heat engines. It is a well-known fact that the thermal efficiency in per cent. is dependent upon the heat or temperature used in the cycle. That is, temperature of reception less the temperature rejection divided by the total temperature of the working fluid, whether of steam in the steam engine or air in the gas or oil engine, whether the engine works with constant temperature cycle, constant volume cycle, or constant pressure cycle, the result is the same, $\frac{T_1 - T}{T_1} = E$ in per cent.

Take the case of a steam engine working between the limits of 150 lbs. pressure and 28 inches vacuum $\frac{819 - 563}{819}$ = 31.3 per cent. as the maximum thermal efficiency and about all we can expect from an engine of this type is from 50 to 55 per cent. of this, or, say, 17 per cent.

The formulae for gas and oil engines are more complicated, as there are your different temperatures during the cycle, but for the purpose of calculating the thermal efficiency we only need to use but two of them and can be calculated from the following formula:

$$\frac{T_4}{T_3} = \frac{(V_2)^{y-1}}{(V_1)} = \frac{T_1}{T_2}$$

and from which we deduce the following $E = 1 - \frac{T_4}{T_3}$ or $E = 1 - \frac{(V_2)^{y-1}}{(V_1)}$ and $\frac{V_1}{V_2}$ is called the compression or expansion ratio, and we will designate it by the letter R, so you will see that the thermal efficiency of constant volume cycle of a constant pressure cycle depends on the compression, expansion or volume ratio, which are the same, and the formula becomes $E = 1 - \frac{1}{R^{y-1}}$ for a mixture in a gas engine y = 1.37, and for air 1.405, say, 1.4 as used in four cycle Diesel and semi-Diesel engines.

Now the volume radio of the Ingersoll-Rand engine is $(\text{Log } 214.7 - \text{Log } 14.7) \div 1.4 = \log \frac{(V_2)}{(V_1)} = 6.8$ and the thermal efficiency becomes $1 - \frac{1}{6.8^{.4}} = 44$ per cent.

The compression ratio of the engine in my charge, working with an absolute pressure of 476 per sq. in., is 12 for the value of R and $E = 1 - \frac{1}{12^{.4}} = 63$ per cent.

Taking the mechanical efficiency as .55 per cent. of the thermal gives the Diesel a mechanical efficiency of 34.5 per cent. and the Ingersoll-Rand engines as 24.2 per cent.

Let us now examine the maximum temperatures of the Diesel and Ingersoll-Rand respectively. Air at 60° F. 521 abs

$T_2 = T_1 \times 12.^4 = 521 \times 12.^4 = 1408$ F. abs. 947° F. scale and as engine works on constant pressure cycle, volume increasing as the heat is supplied, there can not be much increase in temperature though expert opinion is that there is a slight increase.

The final temperature of a constant volume engine is the sum of heat of compression and heat of combustion, and is a complicated formula, but as the compression pressure and final explosion pressure are given and the medium is heated at constant volume, it can be calculated from the following:

$$T = \frac{521 \times 6.8^{.4} = 439.7}{214.7} = 2000^{\circ} \text{ app.}$$

abs. temp. or 1539° F. scale, or about 60 per cent. higher than that of the Diesel engine.

There are other points that I would like to take up, but feel this article is already too long. My intention has been to give some figures to correct the prevalent opinion among engineers that there are high maximum pressures and temperatures in the cylinder of a Diesel oil engine, and to show that though the compression pressures of gas and oil engines are lower the maximum pressures and temperatures are much higher than that of the Diesel cycle.—David Rowlands, Canora, Sask.

SUCCESSFUL STEAM TURBINE OPERATION*

By F. L. Ray

So much has been contributed to the power plant press by operating men on the subject of this paper that it is almost impossible to add anything new on how to get successful operation of turbines. However, a restatement of some essentials will not, we trust, be time wasted, for to be forewarned is to be saved from disaster, and the operator who sticks close to the beaten path laid down by experience will be following a never-erring guide that will lead to success.

The super-turbine units have introduced problems peculiar to their large size, but, generally speaking, the same set of rules will supply from 600 to 60,000 horsepower, the difference being in the use of higher pressure and higher temperature of steam.

There are just three main essentials to turbine operating, and are in order as given—safety, service and economy, and under these heads may be laid down many rules.

Safety.—Of first importance are the safety devices to prevent the over-speeding of turbines, which devices operate to shut off steam if speed reaches a predetermined maximum, usually about 10 per cent. above normal. These devices should be tested as often as machines are shut down by speeding up until the automatic valve trips, for failure of this device has caused many serious troubles that could have been prevented. The operator should exercise eternal vigilance over these safety devices, for this is the price that must be paid for safety.

Service.—Of the next importance to safety of operation there comes service, for in the last analysis this is the prime object of the operation of the turbine, to furnish power for a thousand uses and to supply that power at a stated time and in quantity as contracted for. There must not be any sacrifice of safety to get service, but there may be to get safety and service, a sacrifice of economy.

Economy.—The larger the unit the better the economy, but to get maximum economy from any size turbine it must be operated as near as possible at the load specified by the builder for certain condition of steam pressure temperature and vacuum. Any change from the specifications as to steam pressure, superheat or vacuum will mean a loss.

If you will follow these few simple rules, as given below, your turbine operation will be more successful:

1. Test speed limit device every time turbine is shut down. If device does not work so that throttle is closed within the prescribed limits, then correct the trouble at once.

2. Make sure that automatic vacuum breaking device is always in working order. Do not fail to have a hand-operated vacuum breaker convenient to throttle valve so that if the other device fails then the vacuum can be broken quickly by hand device.

3. Test governor on turbine for control by opening throttle after load is off, and noting speed. Governor should not permit an increase of more than 2 per cent. above normal with full vacuum and steam pressure on. If this test is made once each month, it should suffice.

4. Do not fail to keep governor on drive from circulating pump in good order, for if for any reason the pump should lose its water there would be a wreck due to over-speeding.

5. Lubrication must not be neglected. Use a good grade of turbine oil and provide a filtering system so that all oil can be changed twice each month.

6. Provide clean, pure soft water for sealing glands so that there will be no liming of these parts to cause trouble. Take the turbine apart and thoroughly inspect and clean at least once each year.

7. If possible, always have a spare unit ready to start at a moment's notice. If the spare unit must be down for repair, then every effort must be exerted to get it back into service again, for the next minute you may need it, and without it the service would be interrupted.

8. Plan your repairs to the spare unit, so that if another unit should fail you would have the minimum of interruption to service. Some times these can best be made after midnight or on Sunday when the demand for power is lightest.

9. Take no chances with equipment, if through its failure you should cause an interruption to the service.

10. Regular systematic inspection of apparatus will prevent many an accident and be a safety first move as well as insuring against interruption to service.

11. Do not wait for something to happen, but plan ahead so that your repair work will always be well ahead of the breakdown and thus prevent what every successful operator abhors, an interruption to service.

A turbine will be operated economically if it is successfully operated, for to successfully operate it, it must be operated under conditions conducive to economy. It must be kept in good order, the steam pressure must be just right, the temperature of steam must be neither too high nor too low, the vacuum must be as close to the maximum prescribed as possible at all times.

Therefore, successful turbine operation depends on safety first methods being followed closely, which will give service of the first order, with maximum economy.

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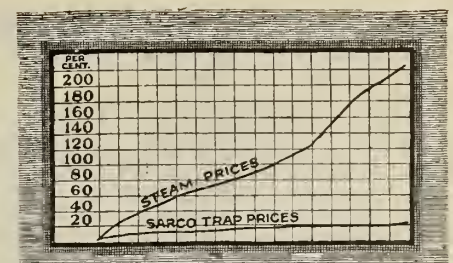
*Read before Indiana No. 16, N.A.S.E.

F. W. Evans, manager of the Toronto branch of the Canadian Fairbanks-Morse Company, has returned to the city after a six weeks' vacation. Mr. Evans' health is much improved as a result of the trip.



Stop Waste at the Coal-Pile

Steam costs 200% more than it did five years ago, but Steam Trap SARCO prices have not increased more than 20%. The relation between cost and saving in dollars and cents is so much greater now than before the war that you cannot afford to leave lines untrapped or badly trapped.

Coal to-day is so high—and frequently so hard to get—that every shovelful counts. It will pay, and pay big, to check up on your steam line and see where coal is being wasted and money being lost through insufficient trapping.

You can put in **three** Steam Trap Sarcos—**stop the loss at three different points**—for the cost of just **one** old-style trap.

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Sarco is so small and compact that it takes little more room than an ordinary elbow—can be installed at steam-wasting points where the bulkiness of old-style traps would make them out of the question. No platform, pit or supports needed.

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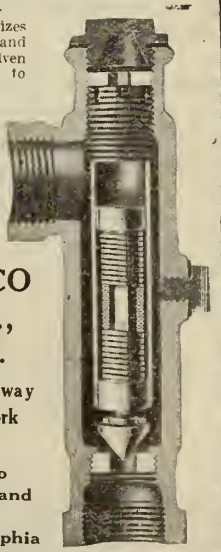

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OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question:—What is meant by the factor of evaporation? What has it to do with the quantity of water in the boiler? With steam at 100-lb. gauge and feed water at temperature of 160 degrees, what is the factor of evaporation?

2. In a flat surface supported by stays what is the allowable pressure when the plate is 7/16 thick and the pitch of stays is 9 x 9 inches? What is the difference in the diameter of direct and diagonal stays?

3. What would be the strengths of three different joints, single riveted lap, double riveted lap, and triple riveted butt strap, when the plate is 7/16ths, the rivets 7/8 and the pitch 2.708 inches?

Answer.—Your first question is on the factor of evaporation, and has nothing to do with the quantity of water in the boiler, but with the amount of heat necessary to heat 1 lb. of water. For instance, to turn 1 lb. of water at 212° into steam at 212° requires 966 B.T.U. Then if your feed water is 160° and steam at 100 lbs., the total heat required will be the difference between 160° and the temperature of steam at 100 lbs. gauge, plus the latent heat. The temperature is 337° and the latent heat is 880.4, so the total heat is 1,217 B.T.U. The feed water is 160, so we have 1,217 — 160 = 1,057 B.T.U. per lb. of water changed to steam. This is more than 966, and the factor of evaporation is 1,057 ÷ 966 = 1.094. Now this means that there is so much less water evaporated per unit of heat. If the boiler is rated at 100 H.P. this means it can evaporate 3,450 lbs. water from 212° to steam at 212° per hour. Now if it evaporates the same weight of water from 160° to steam at 337° it is performing more than 100 H.P. It will be 100 × 1,094 or 1.094 H.P. On the other hand, if it is to keep to 100 H.P. it would only have to evaporate $\frac{34.50}{1.094} = 3153.5$ lbs. In the case of a boiler working at 100 lbs. gauge pressure and feed at 160° and evaporating 34.50 lbs. per hour, to get the equivalent evaporation from and at 212 we simply multiply the water evaporated by the factor of evaporation. To get the horse power we divide the product by 34.5.

The formula for the allowable pressure on a flat plate is

$$\frac{C\ (t + 1)^2}{S - 6}$$

where C is a constant, which varies under different conditions from 90 to 200; t is thickness of plates in 1/16, and S is surface supported. Putting in your figures we get, calling C 90,

$$\frac{90\ (7 + 1)^2}{9 \times 9 - 6} = \frac{90 \times 64}{75} = 78.4$$

The pressure on the plate would then be 9 × 9 × 78.4 = 6350 lbs. If we allow 8000 lbs. per sq. in. on a direct stay the diameter will be

$$\sqrt{\frac{6350}{8000 \times .7854}} = 1.01, \text{ say,}$$

1 inch diameter.

The allowance on a diagonal stay is, according to its length, compared to the distance from the head to where the stay joins the shell. If the length of the stay is 42 and the distance from the head is 40, then the area of a diagonal stay would be to the area of a direct stay as 1.05 is to 1. The area of the direct stay is $\frac{6350}{8000}$, then the area of the diagonal stay will be $\frac{6350}{8000} \times 1.05$ and the diameter will be $\sqrt{\frac{6350 \times 1.05}{8000 \times .7854}}$ inches.

If the stress allowed on a direct stay is 8000 lbs., then on a diagonal it would be $\frac{8000}{1.05} = 7619.$

The joint you give would have percentage as follows:

Single Riveted Lap—Plate Strength $= \frac{P\ D}{P} \times 100 = \frac{2.708 - .875}{2.708} \times 100 = 67.68\%$

Rivet Strength— $= \frac{A \times n}{P \times t} = \frac{7 \times 7 \times .7854 \times 1 \times 16}{8 \times 8 \times 2.708 \times 7} = 50.7\%$

So strength of single riveted lap is 50.7 per cent.

For a double riveted lap the per cent. of plate would be the same, but the rivet strength would be just double. Thus:

$$\frac{A \times n}{p \times t} = \frac{7 \times 7 \times .7854 \times 2 \times 16}{8 \times 8 \times 2.708 \times 7} = 100.1\%$$

For a treble riveted butt strap join the pitch on the outside rows would b 5.416 inches. Thin plate strength woul be $\frac{5.416 - .875}{5.416} \times 100 = 83.8\%$.

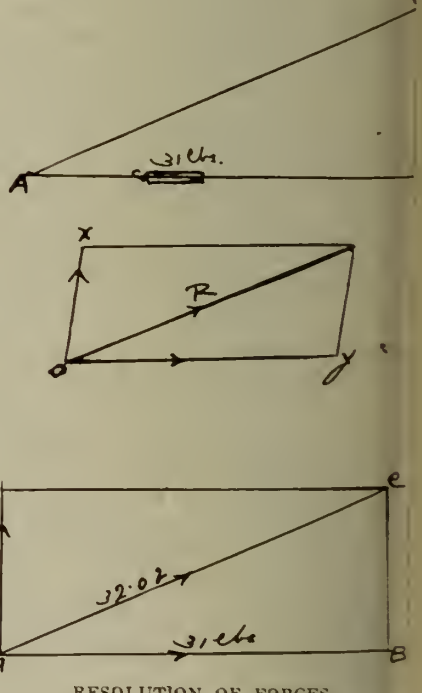
The rivet strength would be $\frac{7 \times 7 \times .7854 \times 8 \times 16}{8 \times 8 \times 5.416 \times 7} \times 100 = 230\%$

The strength would, of course, be 83. per cent. In the formula the letter mean:

A = area of rivet;
n = No. of rivets in a pitch;
P = pitch of rivets;
d = diameter of rivet;
t = thickness of plate.

COMPOSITION OF FORCES

Question:—A B C is a triangle, o which the angle B is a right angle and th sides A C and B C are 60 inch and 1



RESOLUTION OF FORCES.

inch respectively in length. The sprin balance D is subjected to a stress of 3 lbs. What are the components of th stress on D along A C and B C ?

(Continued on page 42)

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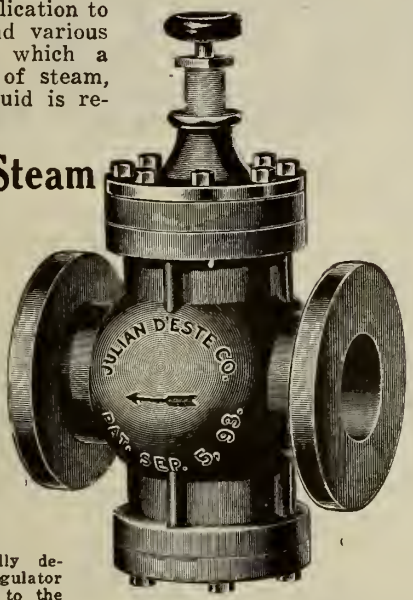

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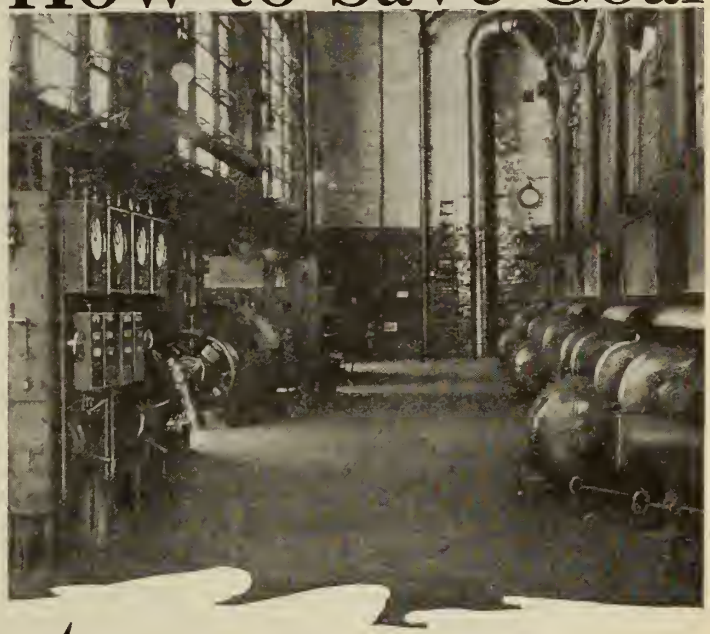

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Test Code for Evaporating Apparatus

Preliminary Draft of the Third of a Series of Nineteen Codes in Preparation by the A. S. M. E. Committee on Power Test Codes

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, under the chairmanship of Fred R. Low, and under its direction are 19 individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the third of these codes to be completed, namely, the Test Code for Evaporating Apparatus.

This Committee will, of course, welcome suggestions for corrections or additions. These should be mailed before April 1 to the Chairman, care of The American Society of Mechanical Engineers.

Test Code for Evaporating Apparatus

Introduction

1. This Code of Tests of Evaporating Apparatus is intended primarily for apparatus heated by steam, such as vacuum pans, or single- and multiple-effect evaporators. The principal use for such evaporators is in the manufacture of alkali, salt, sugar, condensed milk, extracts from chemicals, and similar processes.

Objects

2. The objects of the test should be clearly defined before preparations are made. Some of the purposes for which tests of this character are made are to determine:

(a) The adaptability of the apparatus to the material to be concentrated;

(b) The most feasible and practicable method or methods of operation;

(c) The maximum and minimum range in capacity of the evaporator consistent with economical operation;

(d) The efficiency of the apparatus as a whole, and of its several elements;

(e) Relative capacity and efficiency of the apparatus compared with other apparatus doing similar work;

(f) The location of losses which may be minimized or eliminated by improved apparatus or better methods.

Measurements

3. The measurements involved in the testing of evaporating apparatus heated by steam will depend to some extent upon the object for which the test is conducted as defined in Par. 2 above. In general, these measurements will include the following:

(a) The general data relative to type of apparatus, and principal dimensions as defined in Table A, Items 7 to 20;

(b) The weight or volume of the liquor before and after each effect, and for the apparatus as a whole;

(c) The weight or volume of the steam to each effect and to the apparatus as a whole; also to any auxiliary apparatus;

(d) The pressure, temperature and quality of the steam to each effect; also to any auxiliary apparatus;

(e) The temperature, specific heat and specific gravity of the liquor before and after each effect, and before and after the unit as a whole;

(f) The weight or volume of water evaporated from the liquor;

(g) The weight or volume of condensing water used.

Instruments and Apparatus

4. The apparatus and instruments required for testing evaporating apparatus will include:

(a) Tanks and platform scales for weighing liquor and water, or calibrated tanks, or meters;

(b) Pressure and vacuum gauges;

(c) Thermometers;

(d) Calorimeters for determining the quality of steam;

(e) Hydrometers for determining the specific gravity of the liquors, and degree of concentration;

(f) Apparatus for analyzing the liquors;

(g) Barometer;

(h) Electrical instruments, including voltmeter, ammeter and wattmeter, if electrical measurements are necessary.

Note: For a full description of the use, calibration and accuracy of these instruments and pieces of apparatus, refer to the Code on Instruments and Apparatus.

Preparations

5. The General Instructions, Pars. 4 to 8, should be read, and preparations made accordingly, in so far as these instructions apply to the apparatus to be tested. Take the dimensions of the apparatus and the auxiliaries; note their physical condition; examine for leakages; select and install the testing appliances.

For the heating surface of the evaporating apparatus, measure the surface in contact with the steam, the liquor being in contact with the opposite side.

Where the apparatus is subject to vacuum, examine for leakage of air.

To test for air leaks close up and blank off the apparatus. Pump the air out of the apparatus, blank off vacuum pump, and see if air leaks are noted by decrease in vacuum. Small leaks difficult to find may usually be located by painting the joints and the surfaces, if porous, with a good quality of white lead.

Operating Conditions

6. Determine the operating conditions necessary to conform to the object of the test, and see that these conditions are maintained throughout the test.

Starting and Stopping

7. The pressures, temperatures, densities of liquors, and volumes of same within the evaporator should be the same at the beginning and at the end of the test. The test should be started at the beginning of a commercial cycle where such cycles exist in the operation of the evaporator, and after running the required number of hours it should be stopped at the beginning of the next succeeding cycle.

Duration

8. The duration of the test should depend upon the degree of accuracy demanded by the object for which the test is made. In no case should the duration be less than the regular commercial operating cycle. If the cycles are less than four hours in duration the test should cover at least three complete cycles, and the results of each cycle should substantially corroborate the other two. When the cycles are of four or more hours' duration the test should cover at least two complete cycles and these should be substantially corroborative. Should the operation be carried on in shifts the test should continue at least one calendar day of 24 hours. This length of time should be the duration when the supply of liquor or steam is irregular or intermittent, or when for any reason the regularity of the operation cannot be maintained.

Records

9. The data should be taken and recorded in the manner described in the General Instructions, Pars. 20 to 30. Half-hourly readings of the various instruments will be sufficient, except where there is considerable fluctuation in such readings, in which case more frequent readings must be taken in order to give good averages.

Uniformity of operation may be assisted by the plotting of a chart while the test is in progress, as pointed out in Par. 29 of General Instructions.

10. The data and results should be tabulated in accordance with the form shown in Table A, forming part of this Code, adding items not provided for and omitting items not needed to conform to the object in view. Unless otherwise indicated, the items refer to the numerical averages of the readings which are recorded in the log.

The methods of calculating the results as tabulated, so far as not self evident, or not sufficiently indicated in

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the text for the items, are explained in the following section.

Calculation of Results

Liquor Levels (Table A, Item 28). The datum from which these levels are measured must be so given that it will be possible to calculate the hydrostatic head of the liquor in each effect.

Excess Boiling Degree (Table A, Item 34). The excess boiling degrees of the liquor in any effect is the difference between the boiling temperature of the liquor in that effect and the boiling temperature of water under the same pressure as that of the vapor in the effect.

11. Steam to Condenser (Table A, Item 52). This cannot be measured directly. If a surface condenser is used this item can be determined by measuring or weighing the condensed steam discharged from the condenser. If a jet condenser is used, Item 52 may be calculated from the weight of condensing water and the rise in temperature of the condensing water. The product of these two will give the heat transferred to the condensing water, and this heat divided by the heat in a pound of steam going to the condenser, reckoned from the temperature at which the condensing water leaves the condenser, will give the weight of steam going to condenser. The same item may be determined by taking the difference in weight between feed and discharge liquors in the last effect.

If any retained product is found in the steam to the condenser, this must be taken account of in calculating the weight of steam going to condenser.

12. Evaporation from Liquor (Table A, Item 53). This is the sum of the steam to the condenser (Item 52) and the condensed steam drained from the effects, except that from the first effect. [Total of Item 61, except (a).]

13. Liquor Entering (Table A, Item 56). The weight of liquor entering the first effect is the weight of the feed liquor.

In case it is possible to measure the liquor passing from one effect to the next by pitot tube, venturi tube, or other device, the weight of the liquor entering each effect may be calculated from such measurement, and the temperature and specific-gravity test of the measured liquor. If the condensate can be measured, the liquor entering any effect can be calculated by subtracting the weight of the condensate from the feed liquor, or the liquor entering the previous effect. If it is impossible to measure the liquor passing from one effect to the next, the sub-items of No. 56, except (a), had better be omitted, as the calculation of these items is very unsatisfactory.

14. Evaporation from Liquor in Individual Effects (Table A, Item 58). The satisfactory determination of the several sub-items of this number, except in the case of a vacuum pan, or single effect, depends upon the successful measurement, or calculation, of the liquor passing from one effect to the next. If the liquor can be measured the evaporation in each effect is determined by taking the difference in weight of the liquor entering and leaving that effect (Items 56 and 57), or by measuring the condensate directly.

15. Evaporation from Liquor from and at 212 Deg. Fahr. (Table A, Item 53). This is Item 68 ÷ 970.4.

16. Self-Evaporation (Table A, Item 59). Self-evaporation in any effect is determined as follows: Multiply the weight of the liquor entering that effect by the temperature drop between the boiling point in that effect and the boiling point in the preceding effect, and by the specific heat of the liquor. Divide this quantity by the latent heat of evaporation in the effect considered. The result is the weight of self-evaporation.

17. Heat Contained in Entering Liquor (Table A, Item 63). This is the pounds of feed liquor multiplied by the temperature above 32 deg. Fahr. of the feed liquor, and this product multiplied by the specific heat of the feed liquor.

18. Heat from Steam Supplied to Entire Apparatus (Table A, Item 64). This is the sum of the products of the pounds of steam, from Items 42, 43 and 44, multiplied respectively by the total heat, above 32 deg. Fahr., in a pound of steam of the pressures and qualities used.

19. Heat to Pumps (Table A, Item 65). This is the product of the pounds of steam to pumps, Item 44, by (the heat units in a pound of live steam to pumps minus the heat units in one pound of exhaust steam from pumps corrected for quality).

20. Heat Contained in Discharge Liquor (Table A, Item 66). This is the product of the pounds of discharge liquor (Item 51) by the temperature, above 32 deg. Fahr., of the discharge liquor, and this product multiplied by the specific heat of the discharge liquor.

21. Heat in Steam to Condenser (Table A, Item 67). If the quality of this steam can be obtained this item may be calculated from the weight of steam to condenser (Item 52) and the heat units in a pound of this steam; otherwise this item must be calculated from the heat absorbed by the condensing water; or, pounds of condensing water (Item 62) multiplied by rise in temperature of condensing water [Item 37 (b) —37 (a)]. To this must be added the heat in the condensate above 32 deg. Fahr.

22. Heat Contained in the Evaporation from Liquor (Table A, Item 68). This is the heat in the steam going to the condenser, plus the heat in the condensed steam drained from the effects (except that drained from the first effect: Item 67 + (Item 73 — Heat in condensed steam from first effect).

23. Heat Contained in Entrained Product (Table A, Item 69). From the analysis of the steam to the condenser (Item 92) the amount of entrained product is determined. The weight of this entrained product, multiplied by its temperature above 32 deg. Fahr., and this product, multiplied by the specific heat of the entrained product, will give the heat in such product escaping with steam to condenser.

24. Heat Supplied to Heaters (Table A, Item 70). This is the product of the pounds of live steam to heaters (Item 42) by the total heat above 32 deg. Fahr. in a pound of such live steam. To this must be added the heat supplied from exhaust steam, if any. This is the product of the pounds of exhaust steam to heaters (Item 47) by the total heat above 32 deg. Fahr. in a pound of such exhaust steam. In determining the heat in the steam the quality of the steam must be taken into account.

25. Heat in Water from Heaters (Table A, Item 71). This is the product of the pounds of water discharged from heaters (Item 60) by the temperature of such water above 32 deg. Fahr.

In case of more than one heater the heat will need to be calculated for each heater separately and the sum of the several quantities taken.

26. Heat Supplied to the Effects (Table A, Item 72). This is the product of the pounds of live steam to the effects (Item 43) by the total heat above 32 deg. Fahr. in a pound of such live steam. If exhaust steam is supplied to the effects its heat must be added to the above. Pounds of exhaust steam (Item 48) multiplied by the total heat above 32 deg. Fahr., in a pound of exhaust steam.

27. Heat in Condensed Steam Drained from Effects (Table A, Item 73). This is condensate taken from the steam space of an effect. In case of more than one effect this should be passed along to the next effect if possible, where its heat may, in part at least, be transferred to the liquor. This heat is the product of pounds of condensed steam [Item 57 (b)] multiplied by the temperature above 32 deg. Fahr. of such condensate. In case the apparatus has more than one effect the heat must be calculated for each effect separately, and the sum of the several quantities taken.

In case the condensed steam flows from the steam space of one effect to that of the next effect its temperature should be measured at point of leaving the last effect of the series. This temperature, in degrees above 32 deg. Fahr. multiplied by the pounds of condensed steam leaving the last effect will give the heat in the total condensed steam drained from the effects.

28. Heat Discharged from the Effects (Table A, Item 74). This is the sum of Items 66, 67, 68 and 73.

29. Apparent Heat-Transmission Coefficients. The apparent heat-transmission coefficient in any effect is obtained by dividing the total heat transmitted per hour in that effect by the heating surface in that effect, and by the ap

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parent temperature drop. The apparent temperature drop is the difference between the temperature corresponding to the pressure of the heating steam and the temperature corresponding to the pressure in the vapor space of the effect.

The total heat transmitted in any effect is not the heat corresponding to the evaporation in that effect. It is less than this quantity by the heat in self-evaporation. The total heat transmitted is therefore determined by subtracting from the total evaporation (Item 58) the self-evaporation (Item 59), and multiplying this difference by the total heat (above the temperature of the vapor) in one pound of steam at the pressure and temperature of the vapor in the effect.

30. Corrected Heat-Transmission Coefficients (Table A, Item 82). Apparent heat-transmission coefficients, as outlined in Par. 29, may be corrected for

(a) Excess boiling degrees
(b) Hydrostatic head
(c) Both excess boiling degrees and hydrostatic head.

The report should clearly specify which of these corrections have been made.

If a coefficient is to be corrected for excess boiling degrees, the heat transmitted, as explained in Par. 29, is to be divided by the heating surface and by the temperature drop between the temperature corresponding to the pressure in the heating space and the actual boiling point of the surface liquor in the effect in question.

If a coefficient is to be corrected for hydrostatic head the total heat transmitted, as explained in Par. 29, is to be divided by the heating surface and by the temperature difference between temperature corresponding to the pressure in the heating space and the boiling point of the liquor at the mid-point of the hydrostatic head. This last temperature is to correspond to a pressure equal to the pressure of the vapor space plus a pressure due to a column of liquor equal to one-half the hydrostatic head.

Evaporative Ratio and Efficiency of Individual Effects

31. Overall Thermal Efficiency of the Entire Equipment (Table A, Item 75). This is the ratio of the heat contained in the total evaporation from liquor, to the heat from steam supplied to entire apparatus. Item 68 divided by Item 64, and the quotient multiplied by 100 to give percentage.

32. Thermal Efficiency of the Effects (Table A, Item 76). This is the ratio of the heat contained in the evaporation from liquor to the heat supplied to the effects. Item 68 divided by Item 72, and the quotient multiplied by 100 to give percentage.

If the evaporation from liquor in each effect [Item 58 (b)] is calculated, then these figures, with those of Item 61 (b), may be used to check the above quantity of heat in steam evaporated from liquor, or to figure the efficiency of each effect, and of all effects.

33. Thermal Efficiency of Heaters (Table A, Item 77). This is the ratio of the heat put into the liquor in its passage through the heaters to the heat supplied to the heaters.

Item 50 multiplied by [Item 33 (a) — Item 32 (a)] and by the specific heat of the feed liquor.

The above product divided by Item 70, and this quotient multiplied by 100, will give percentage.

Economy

34. Evaporation Per Pound of Total Steam Used (Table A, Item 83). This is Item 51 ÷ Item 45.

35. Evaporation from and at 212 Deg. Fahr. Per Pound of Total Steam Used (Table A, Item 85). This is Item 54 ÷ Item 45.

TABLE A—DATA AND RESULTS OF EVAPORATING APPARATUS TEST.
(A.S.M.E. Code of 1920)

General Information.

(1) Date of test .....
(2) Kind of apparatus under test (vacuum pan, multiple-effect evaporator, etc.) .....
(3) Location .....
(4) Owner .....
(5) Builder of apparatus .....
(6) Test conducted by .....

Description, Dimensions, etc.

(7) Type of apparatus .....
(8) Dimensions of shells .....
(9) Material of tubes and tube sheets .....
(10) Number of tubes in each effect .....
{ Length.....
{ Diameter.....
(11) Heating surface in each effect .....sq. ft.
(12) Number and type of liquor heaters .....
(13) Number of tubes in each heater .....
{ Length.....
{ Diameter.....
(14) Heating surface in each heater .....sq. ft.
(15) Liquor heating surface in each heater.sq. ft.
(16) Type and make of condenser equipment....
(17) Condensing surface .....sq. ft.
(18) Type and dimensions of vacuum and circulating pumps .....
(19) Kind of liquor concentrated .....
(20) Characteristics of liquor concentrated.....

Test Results.

(21) Duration of test .....hr.

Average Pressures and Temperatures—

(22) Steam pressure by gage .....lbs. per sq. in.
(23) Barometric pressure .....in. of mercury
(24) Absolute steam pressure.....lb. per sq. in.
(25) Pressure in exhaust-steam line from pumps .....lb. per sq. in.
(26) Pressure or vacuum:—
(a) 1st effect ....lb. pressure....in. vacuum
(b) 2nd effect ....lb. pressure....in. vacuum
(c) 3rd effect ....lb. pressure....in. vacuum
(d) 4th effect ....lb. pressure....in. vacuum
(e) 5th effect ....lb. pressure....in. vacuum
(f) 6th effect ....lb. pressure....in. vacuum
(27) Vacuum in the condenser.....in of mercury
(a) Corresponding absolute pressure .....lb. per sq. in.
(28) Liquor levels:—
(a) In 1st effect .....inches
(b) In 2nd effect .....inches
(c) In 3rd effect .....inches
(d) In 4th effect .....inches
(e) In 5th effect .....inches
(f) In 6th effect .....inches
(29) Temperatures of saturated steam corresponding to the vapor pressure in:—
(a) 1st effect .....deg. fahr.
(b) 2nd effect .....deg. fahr.
(c) 3rd effect .....deg. fahr.
(d) 4th effect .....deg. fahr.
(e) 5th effect .....deg. fahr.
(f) 6th effect .....deg. fahr.
(30) Steam temperatures:—
(a) Superheated steam .....deg. fahr.
(b) Normal temperature of saturated steam .....deg. fahr.
(c) Temperature of exhaust steam deg. fahr.
(31) Temperature of liquor:—
(a) Entering 1st heater.....deg. fahr.
(b) Entering 2nd heater.....deg. fah
(c) Entering 3rd heater.....deg. fah
(d) Entering 4th heater.....deg. fah
(e) Entering 5th heater.....deg. fah
(f) Entering 6th heater.....deg. fah
(32) Temperature of liquor:—
(a) Entering 1st effect.....deg. fah
(b) Entering 2nd effect.....deg. fah
(c) Entering 3rd effect.....deg. fah
(d) Entering 4th effect.....deg. fah
(e) Entering 5th effect.....deg. fah
(f) Entering 6th effect.....deg. fah
(33) Temperature of liquor:—
(a) Leaving 1st effect.....deg. fah
(b) Leaving 2nd effect.....deg. fah
(c) Leaving 3rd effect.....deg. fah
(d) Leaving 4th effect.....deg. fah
(e) Leaving 5th effect.....deg. fah
(f) Leaving 6th effect.....deg. fah
(34) Excess boiling degrees of liquor:—
(a) In 1st effect .....deg. fa
(b) In 2nd effect .....deg fa
(c) In 3rd effect .....deg fa
(d) In 4th effect .....deg. fa
(e) In 5th effect .....deg. fa
(f) In 6th effect .....deg. fa
(35) Temperatures of condensed steam discharged:—
(a) From 1st heater .....deg. fa.
(b) From 2nd heater .....deg. fa
(c) From 3rd heater .....deg. fa
(d) From 4th heater .....deg. fa.
(e) From 5th heater .....deg. fa
(f) From 6th heater .....deg. fa.
(36) Temperatures of condensed steam.—
(a) Drained from 1st effect.....deg. fa.
(b) Drained from 2nd effect.....deg. fa
(c) Drained from 3rd effect.....deg. fa
(d) Drained from 4th effect.....deg. fa
(e) Drained from 5th effect.....deg. fa
(f) Drained from 6th effect.....deg. fa
(37) Temperature of condensing water:—
(a) Entering condenser .....deg. fa.
(b) Leaving condenser .....deg. fa
(38) Temperature of air in evaporating room .....deg. fa
(39) State of weather:—
(a) Temperature of external air...deg. fa
(b) Relative humidity of external air .....per cent.

(To be continued)

QUESTIONS AND ANSWERS

(Continued)

Answer:—What our correspondent s after is, we think, an explanation of e resolution of forces. His question s stated in a rather peculiar manner, s there is no need to suppose the prese e of a spring balance. A force of 1 lbs. acts along the line A B. Now force would be one of the compone s of the resultant force, which is expres in magnitude and direction by the di onal of the parallelogram of for Any two forces acting through a co mon point, can be resolved into a sin force acting through the same poin the following manner. Let the lines Y and OX represent in magnitude d direction two forces acting through t point O. If we complete the parall gram as shown, the diagonal will re sent in direction and magnitude the e sultant of the two forces. Similarl we have a single force we can res it into two forces at right angles to e other. In the case given we can ass the two forces to be acting along B and AB through a common point A. h force acting on the BC will be equ t AB sine A, which is taking the meas ments given, 31 x 15 60, while the f c acting on AC is equal to AB cos A, which is 31 .968. These give us respectively 7.75 and 32.07 lbs. The compon t forces are 7.75 and 31, while the re tant force is 32.02.

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That are easy to install—air and gas tight, that cannot crack, chip, spawl or peel off—no separate fire brick, no mortar joints and not affected by expansion and contraction use

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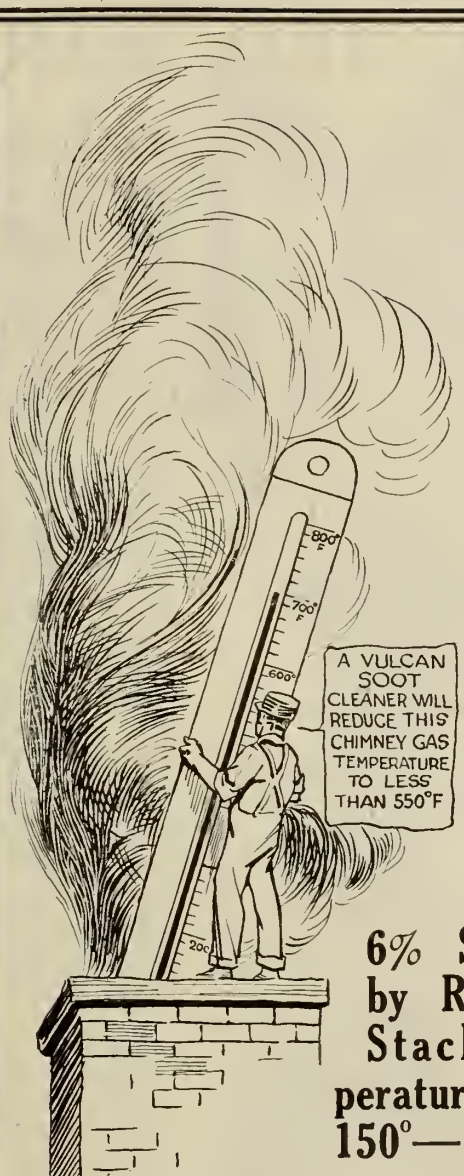
POWER EQUIPMENT



6% Saved by Reducing Stack Temperature 150°—

A certain plant found, by pyrometer test, that it had a stack temperature of 700 degrees. Obviously, it was losing a considerable amount of the heat value of the coal burned.

About that time, it installed Vulcan Soot Cleaners on its five boilers. Almost immediately the stack temperature dropped to less than 550 degrees—a clean drop of 150 degrees.

Analysis showed the coal to have a heat value of 12,000 B.T.U. With this as a basis, it was determined that Vulcan Soot Cleaners were responsible for a fuel saving of 6 per cent.

If your stack temperature is too high, it will pay you to look into Vulcan Cleaners as a means of lowering your present costs.

"Spending $796 to Earn $1017.40"

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William W. Hicks & Co.,
567 Banning Street.

TORONTO
Green's Economiser, Ltd.,
Kent Building.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	29 50
1¾-in.	29 75	27 00
2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
3½-in.	63 50	43 50
4 -in.	85 00	55 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$5 25	$5 25
Plates, ¼-in. up	4 75	4 75

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21 74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1:54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

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Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger, net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C. 26c lb. F.O.B. Toronto.

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	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal	06
Lard Oil, per gal	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15
Standard	0 15 to 0 40
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15
Carriage bolts, 7 16 and up	Net
Coach and lag screws	20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7 16 and over	5
Machine bolts, ⅜-in. and less	30
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	—25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 27½
Solder, guaranteed	29½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43
Emery cloth	list, plus 37½
Sal soda	0 03
Sulphur, rolls	0 05
Sulphur, commercial	0 04
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toron
Bars, ½ to 2-in.	$32 00	$34
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	34 00	38
Copper sheet, tinned, 14 x 60, 14-oz.	40 00	42
Copper sheet, planished, 16-oz. base	46 00	48
Braziers', in sheets, 6 x 4 base	38 00	41
Copper tubing, seamless	0 43	0

RUBBER BELTING

Standard	10
Best grades	15

WASTE

XXX Extra	21	Atlas	1
Peerless	22	X Empire	1
Grand	21½	Ideal	1
Superior	21½	X Press	1
X L C R	14½		

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Lion	13½	Popular	1
Standard	12	Keen	
No. 1	14		

Wool Packing

Arrow	35	Anvil	2
Axle	28	Anchor	1

Washed Wipers

Select white.	20
Dark colored.	0
Mixed colored	10

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Drilling cables, Manila	0 3
Plumbers' oakum, per lb	0 1
Packing, square, braided	0 3
Packing, No. 1 Italian	0 4
Packing, No. 2 Italian	0 3
Pure Manila rope	2
British Manila rope	2
New Zealand hemp	2
Transmission rope, Manila	0 4
Cotton rope, ¼-in. and up	0 8

METALS	Gross Mont.	Toron
Tin	$39 00	$4
Spelter	7 75	
Lead	5 75	
Antimony	8 00	
Aluminum	34 50	3

Prices per 100 lbs.

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Worthington was the pioneer in this branch of the power field, and for more than forty years has led the way in designing and constructing condensing apparatus of every type.

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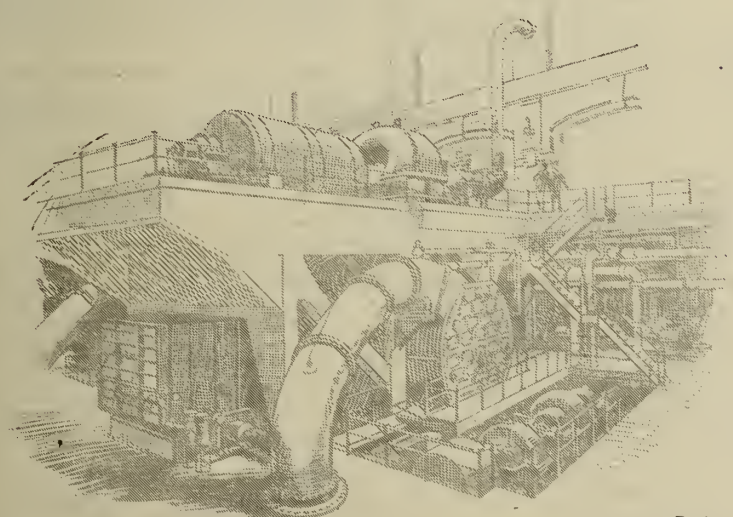
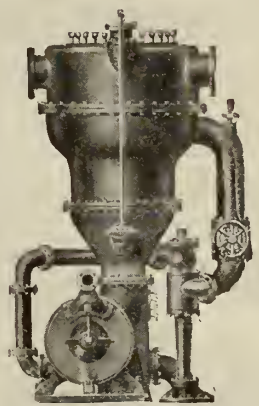


B-40

Spirojector Condenser

Counter Current Barometric Condenser



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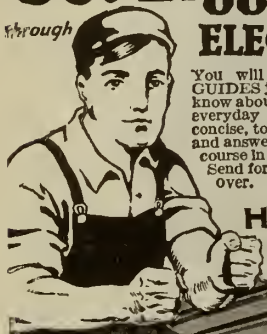

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PORTABLE BOILERS—LOCOMOTIVE TYP on wheels, each 15 horsepower, with engi mounted on boilers; can get Government cer ficates for 90 and 100 pounds working pressu cheap; also 40 horsepower, high speed Leon automatic engine. Apply, mentioning "Pow House," to Henry Engineering Co., 71 Bay Str Toronto. (p

BOILERS AND POWER PLANT EQUIPME bought by the Henry Engineering Compa (Henry-Rumgay-McBryde), 71 Bay St., Toron Mention "Power House." (p

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LEATHER AND RUBBER BELTING, USI but in good condition; at about half new pr Apply, mentioning "Power House," to Tarshis Sons, 400 Front St. East, Toronto. (p.f.)

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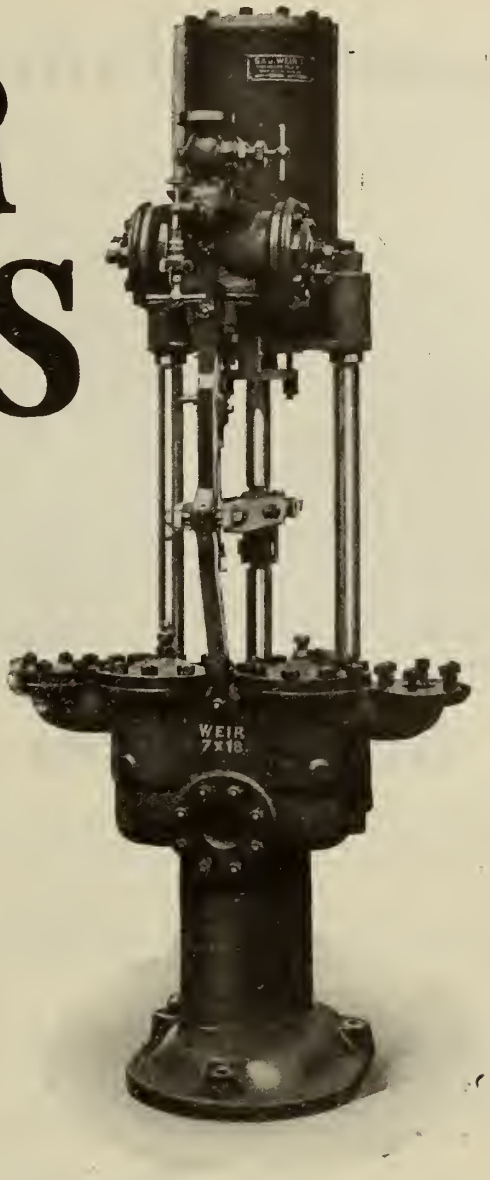

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"The Curtain is Rolled Down, for seventy-three years makes a long act," says George. "Recalling three score and ten of these years has been a pleasant though difficult task; thirty-three of them have been spent in the service of the C.P.R., and one cannot but realize that the corridors of the Company's office will not long be trodden by the older ones of this generation and that some of us perhaps will soon not even be a memory."

"There Were Giants in Those Days"

The concluding instalment of this remarkable, all-Canadian feature, is the biggest and best of the lot—and here is the proof: There are seven full magazine pages, chock full of stories of those amazing days when the C.P.R. was conceived and constructed; human, hitherto unpublished details of the lives and careers of those three veteran founders, and, later, presidents of our first transcontinental: **Lord Mount Stephen**, the late **Sir William Van Horne**, and **Baron Shaughnessy, K.C.V.O.** And funny stories! Well, just read about Baron Shaughnessy's racing experiences; the pranks George Ham and William Stitt used to play on each other; Fred Cook's "German Band," and countless other incidents that could only be retained in such a mind—and heart—as that possessed by Canada's grand old raconteur.

Big Features of Fiction and Fact

"Personality, Plus"—By Guy Morton.
A fascinating story about an advertising agency man who put across a trick to close a contract—and then gave the whole game away.

"Lenix Fools the Jinx"—By Archie P. McKishnie.
Another of those deliciously droll Lenix Ballister negro stories, in which more than the usual number of comic and absurd scenes are depicted.

"Pawned"—By Frank L. Packard.
The third instalment of this masterful serial goes a long way to show how the triple regeneration is going to be effected.

"Broadway to Brussels"—By C. C. Jenkins.
The story of the rise of J. H. Gundy, a shy youngster, who developed into one of Canada's most brilliant orators and a leading financier.

"Little Bundles of Pluck"—By Agnes C. Laut.
In this, Miss Laut tells with graphic pen the story of some of the war brides who are making good out on the lonely prairies, where they and their husbands have been located by the S.S.B.

"A Woman Would Know ——"—By Charles G. Booth.
This whole gripping story centres around the possession of a wee bundle of humanity, cursed with a dope-fiend father. There is plenty of love interest, too.

"Those Who Stood in Darkness"—By J. L. Rutledge
A symposium giving the opinions of a number of Ministers of various denominations on some of the doubts which have arisen in this war aftermath, in the minds of many Christians—and others. An Easter Message.

Review of Reviews

"What Does Future Hold for Mankind?" H. G. Wells

"The World's New Leaders." Sir Philip Gibbs

"Labor Espionage in the U.S." Sydney Howard

"Bismarck's Account of Dismissal." Neue Zuricher Zeitung

"Ireland, the Enemy?" Harold Cox

"Devil Duval's Treasure." Chambers's Journal

"A Winged Torpedo Boat." "Tin-Fish"

"How Van Horne Rose." Walter Vaughan

"Criminal Tribes of India." London "Times"

"Salvaging Submarine Victims." Stuart Martin

"Greece's Great Renunciation." Pierre de Lacretelle

"Labor Must be Partner." George A. Greenwood

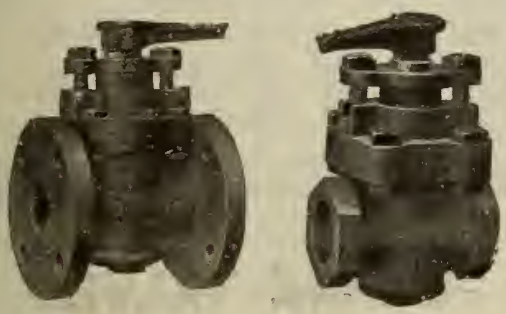
"Common-Sense Bridge." Manning Foster

MARCH 15th ISSUE On All News-stands 20c

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

HOMESTEAD
QUARTER TURN VALVES



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PITTSBURGH, PA.
Works : Homestead, Pa.

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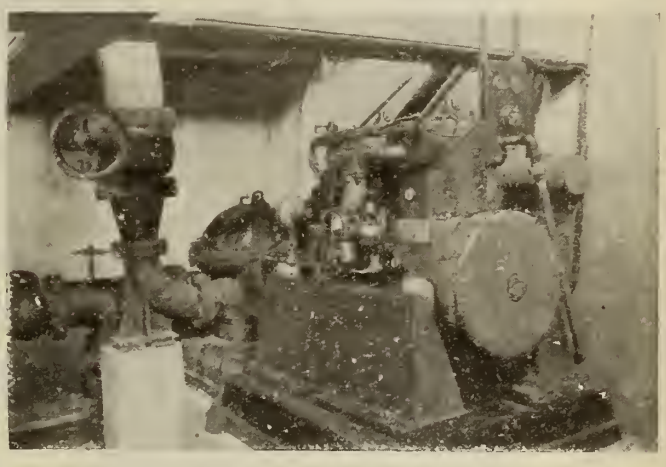

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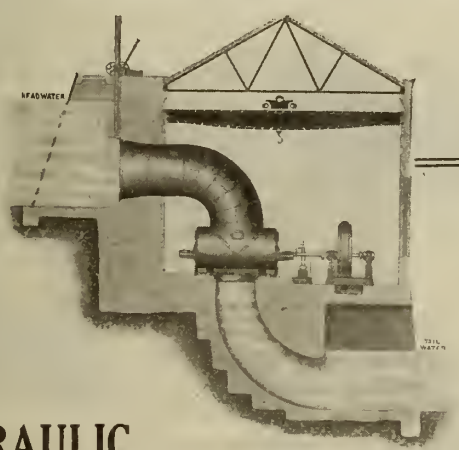

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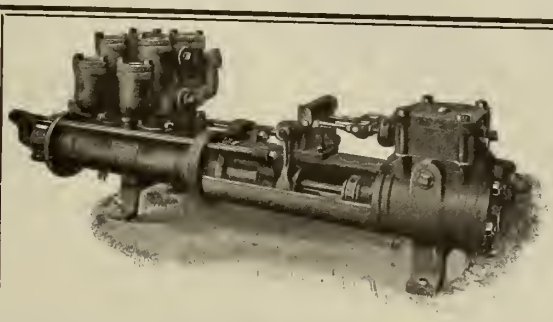

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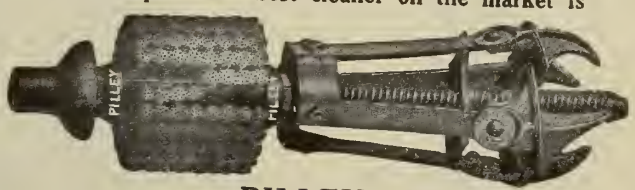

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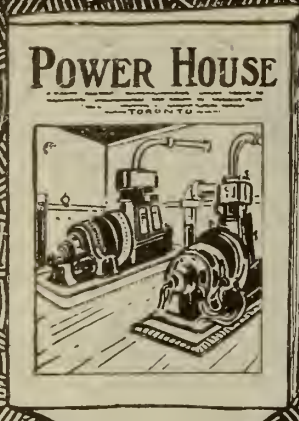

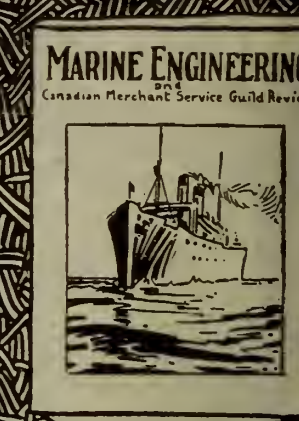

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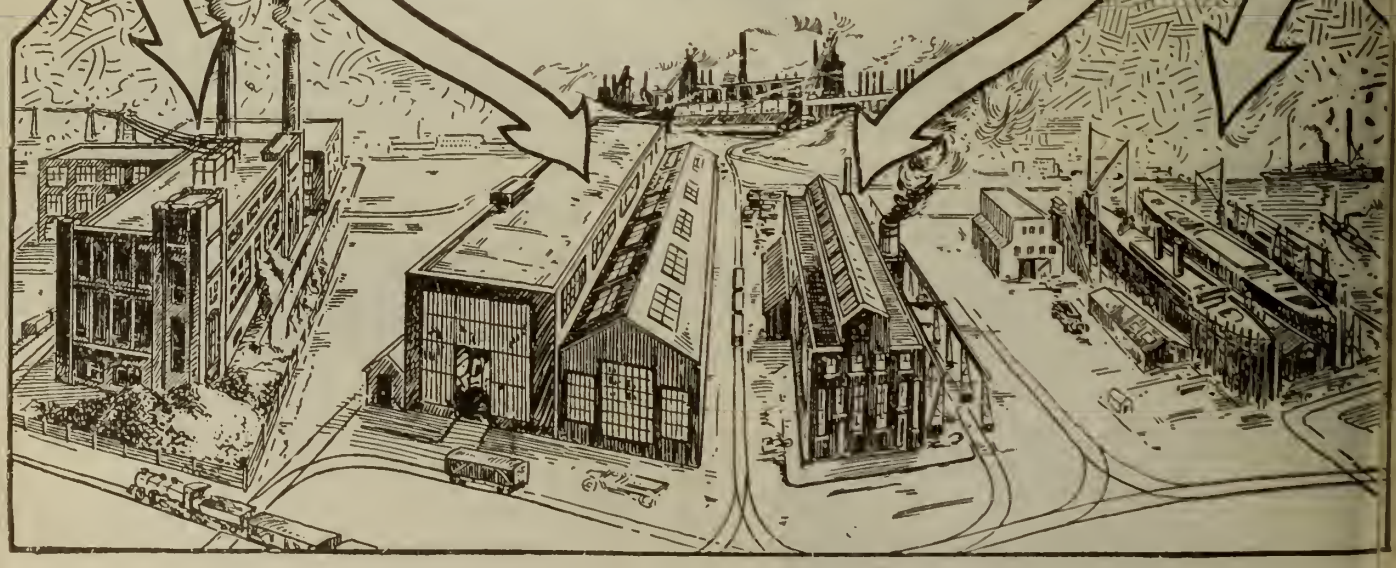

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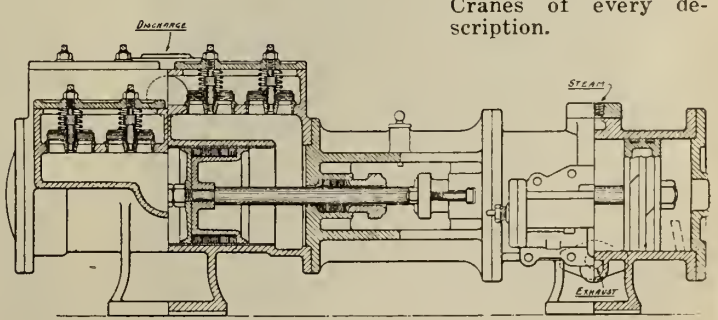

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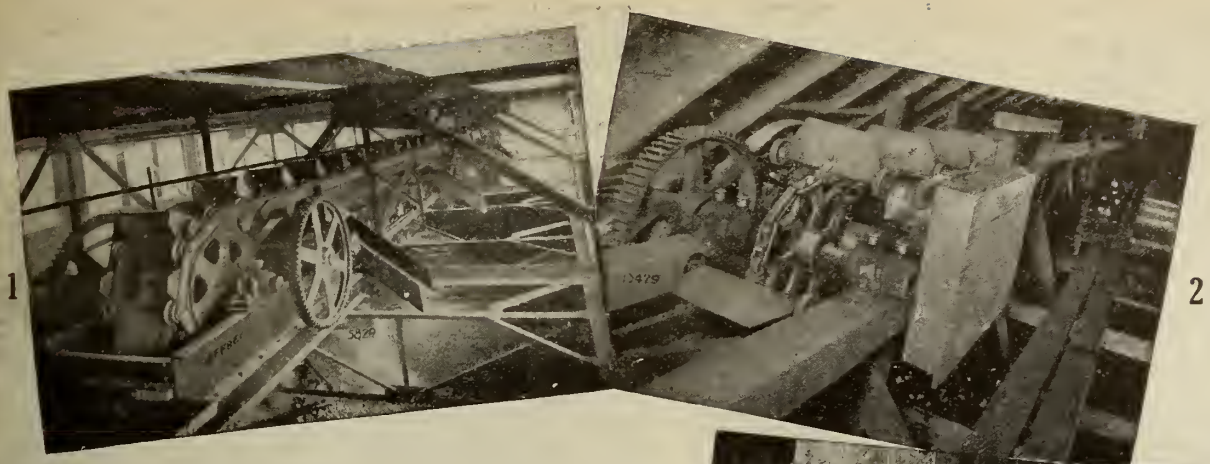

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3

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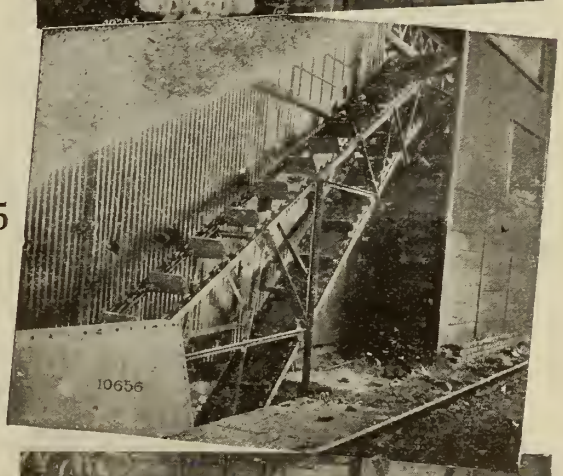
For Handling Coal In Boiler Houses

4



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6

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6—Scraper Conveyer consisting of Double Strands of "Vulcan" Chain with steel cross bars and scrapers, handling coal to bunkers.

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Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Shell Bar Bolco Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co. Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Bolco Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co, Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp. Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Bolco Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Bolco Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Bolco Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Bolco Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk Con.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto
Green's Economiser, Ltd., Toronto, Ont
Uehling Instrument Co., New York, N.Y

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont
Taylor Instrument Co's., Rochester, N.Y
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto

LEATHER BELTING
W. J. Brown (Tucks), Montreal

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

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LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
W. J. Brown (Tucks), Montreal.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

PACKING, ENGINE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Beldam Asbestos (Canada) Co., Toronto.
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Beldam Asbestos (Canada) Co., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm, B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co. Galt
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

A Personal Message to Executives

Concerning

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If you are laying plans to put your plant in shape for the demands which will come on it when production is once more normal, you will be interested in the advantages of Superheated Steam.

Superheated steam reduces fuel bills from 10 to 20 per cent. It adds about 25 per cent. in boiler capacity to present installations at about one-fifth the cost of obtaining this increased capacity by installing new boilers.

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Your engineering department will know.

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Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all Purposes
British Columbia Representatives: The Taylor Engineering Co., Limited, Vancouver, B.C.

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
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Yarnall-Waring Co., Philadelphia, Pa.

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American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

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Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
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RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

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Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto,
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Haya Corp., Michigan City, Ind.

RECORDEDS CO2
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.
Uehling Instrument Co., New York, N.Y.

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Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

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S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Paper Co., Ltd., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAFES
R. C. Miller Oil & Supply Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

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Waterous Engine Works Co., Brantford.

SMELTING LININGS
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Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

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L. S. Starrett Co., Athol, Mass.

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SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
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Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
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MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

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Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
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S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
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American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

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Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

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Darling Brothers, Ltd., Montreal, Que.
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Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

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Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

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Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
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Lyman Tube & Supply Co., Ltd., Toronto

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Mason Reg. & Eng. Co., Ltd., Montreal
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MacGovern & Co., Inc., Montreal, Que.

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Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.

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Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
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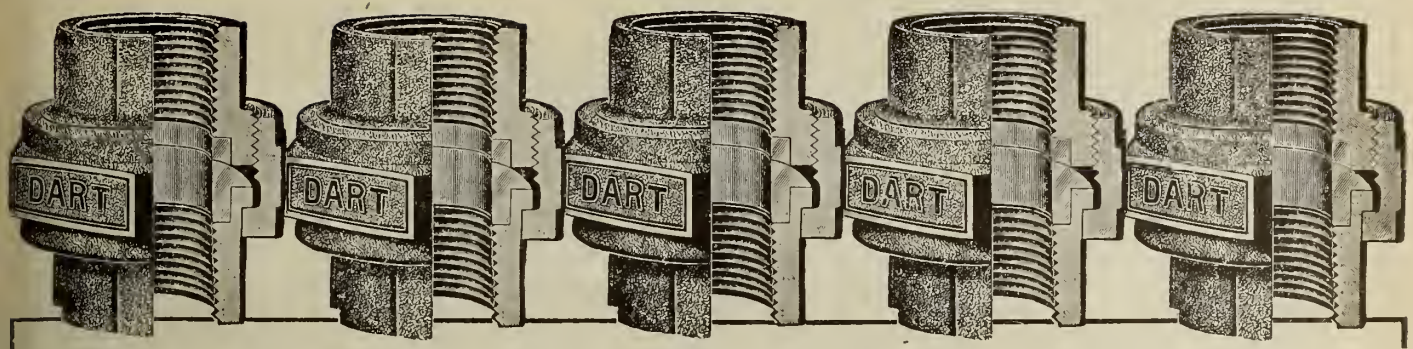
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.



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The Bronze to Bronze feature eliminates all possibility of deterioration at the vital part. Bronze will not rust or corrode.

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Mueller Mfg. Co., Ltd., Sarnia.
alve Engineering Company, Toronto.
omestead Valve Mfg. Co., Pittsburg.
enkins Bros., Montreal.
enberthy Injector Co., Windsor, Ont.
ratt & Cady, Hartford, Conn.
ictoria Foundry Co., Ltd., Ottawa.
ork Manufacturing Co., York, Pa.

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err Engine Co., Walkerville, Ont.
ratt & Cady, Hartford, Conn.
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mpire Mfg. Co., Ltd., London, Ont.
a. Morrison Brass Mfg. Co., Toronto.
ueller Mfg. Co., H., Sarnia, Ont.
ratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

ratt & Cady, Hartford, Conn.

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abcock & Wilcox, Ltd., Montreal.
n. Fairbanks-Morse Co., Montreal.
arling Bros., Ltd., Montreal, Que.
ldie & McCulloch Co., Galt.
omestead Valve Mfg. Co., Pittsburg.
s. Morrison Brass Mfg. Co., Toronto.
ell Bar Boico Supply, Ltd., Toronto.
enkins Bros., Ltd., Montreal.
nkenheimer Co., Cincinnati, O.
ratt & Cady, Hartford, Conn.
atson & McDaniel Co., Philadelphia.
arnall-Waring Co., Philadelphia, Pa.

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'Este Co., Julian, Boston, Mass.
rr Engine Co., Walkerville, Ont.
son Regulator Co., Boston, Mass.
s. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., Ltd., Sarnia.
nberthy Injector Co., Windsor, Ont.
ratt & Cady, Hartford, Conn.
ell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

ell Bar Boico Supply, Ltd., Toronto.
n. Fairbanks-Morse Co., Ltd., Montreal

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

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Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

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VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

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Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sarco Company, Inc., New York.

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Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Arthur S. Leitch Co., Ltd., Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

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Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

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C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
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VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

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Kerr Engine Co., Walkerville, Ont.
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Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

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Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

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Darling Bros., Ltd., Montreal, Que.
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W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
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Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

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WATER HEATERS AND WHISTLES

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WATER WHEELS

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J. C. Wilson Mfg. Co., Ltd., Belleville.

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Shell Bar Boico Supply, Ltd., Toronto.

WASTE

R. C. Miller Oil & Supply Co., Ltd., Montreal

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

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WHISTLES

Penberthy Injector Co., Windsor, Ont.
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Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS

Holden Co., Ltd., The, Montreal.

WIPERS

R. C. Miller Oil & Supply Co., Ltd., Montreal

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

Improvements in Centrifugal Pumps

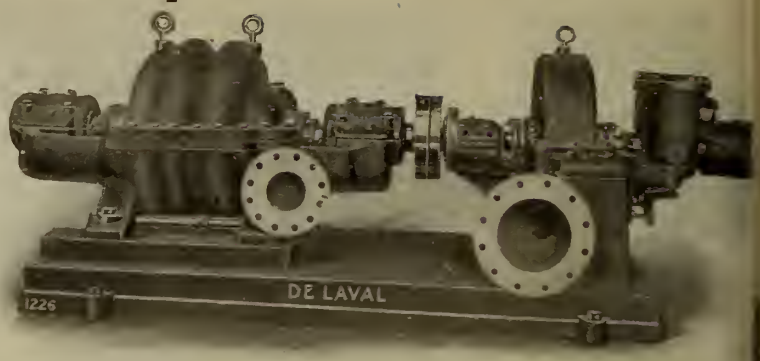
MOST of the features which distinguish the modern, efficient centrifugal pump from the old, inefficient pump limited to low heads were introduced by the De Laval Steam Turbine Co., and many of them are still peculiar to De Laval pumps.

The horizontally split casing with the suction and discharge openings in the bottom half, permitting the top half to be removed without breaking pipe joints or disturbing the alignment of the pump, was first introduced in a De Laval pump. It avoids the tedious, and sometimes almost impossible job of pulling parts out of a pump axially and it enables one to see that everything is put back as it should be.

Removable rings, upon both the impeller and upon the casing, where the two come close together, is another characteristic De Laval improvement, as also are the De Laval labyrinth rings by which leakage and loss of power are greatly reduced.

The De Laval pump first demonstrated that the highest efficiencies can be attained without the use of diffusion blades, and can be maintained much more successfully without than with diffusion blades.

The De Laval pump was one of the first in which the shaft was protected throughout against corrosion by water and wear by stuffing boxes by means of cast bronze sleeves or bushings. The De Laval pump also differs from many others in that a shaft of ample thickness to prevent rubbing under any conditions is employed.



The De Laval pump uses vertically split ring-oiled bearings which can be removed in halves.

In the De Laval pump the end balancing problem has been solved.

The cut shows a multi-stage pump of latest design driven by a De Laval velocity stage turbine.

Unique features of the De Laval pump, of the greatest importance to the purchaser, are:

Manufacture on a limit-gage, interchangeable basis, so that repairs or replacements ordered from the shop can be inserted by unskilled men, and

A policy of rigorous guarantees covering efficiency and other characteristics, coupled with the practice of testing each unit before it leaves the shop.

The De Laval engineering staff would be glad to give you the benefit of their experience in centrifugal pump engineering.

DE LAVAL STEAM TURBINE CO. TRENTON, N.J.

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LIMITED, 73 King Street West, Toronto
THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.
TAYLOR ENGINEERING CO., LTD., Vancouver

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WE — FU — GO AND SCAIFE

WATER

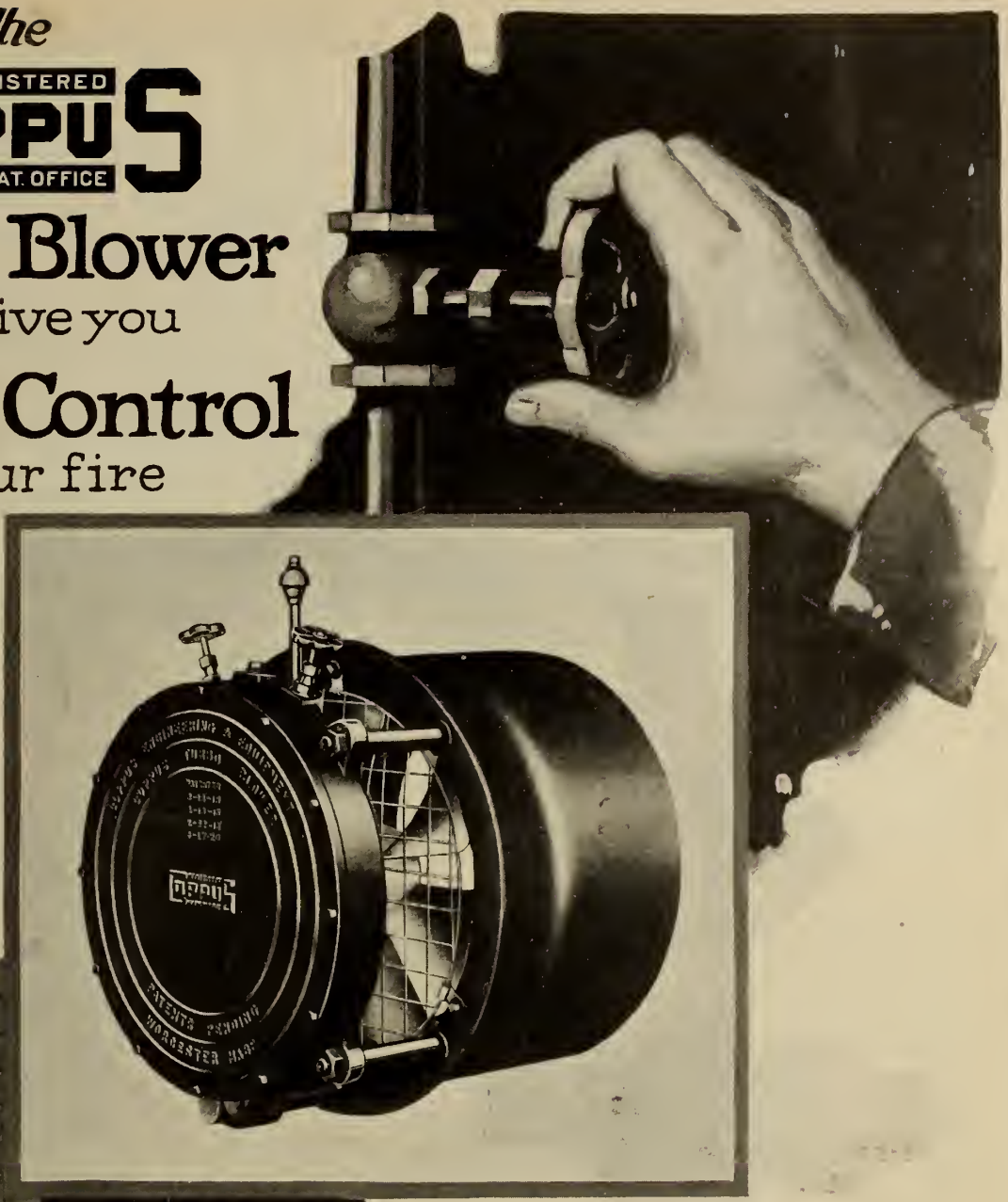
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

The

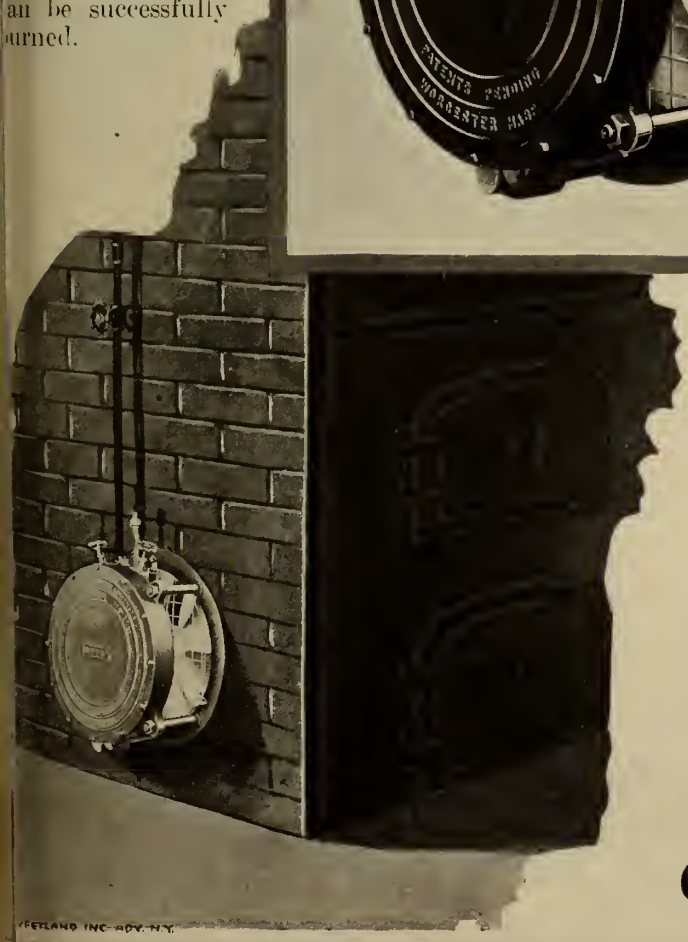
REGISTERED COPPUS U.S. PAT. OFFICE

Turbo Blower will give you Valve-Control of your fire



ONCE unheard of — to-day standard practice in our most efficient boiler plants—*valve control of your fires.*

A turn of the valve gives an immediate "pick-up" of your fires. More steam in a hurry—and; mind you, the cheapest and poorest grades of coal can be successfully burned.



It is almost as easy to install a Coppus Turbo Blower under your boilers as it is to put an electric fan in your office. Merely cut a hole in the boiler setting—mason in the casing—make the simple steam connection, and it's done. Then you have valve-control of your fire—as easy as regulating the flame of a gas jet.

Coppus Turbo Blowers are standard equipment in efficiently operated boiler plants.

Our booklet contains interesting blower data. Ask for it.

Coppus Engineering & Equipment Co.

341 Park Ave., Worcester, Mass.

Morrison Steam Goods

"I know no way of judging the future but by the past," said Patrick Henry.

The modern power plant engineer paraphrases this by saying, "I know no way of judging the service which I shall secure from a line of steam specialties but by their past performance."

"Every installation is a demonstration of merit."

The James Morrison Brass Manufacturing Co., Limited

93-97 Adelaide Street West, Toronto

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

REAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 1103 Union Trust Building

ol. XIV.—No. 7. Publication Office, Toronto—April 5, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Look at the Inside

APPROVED
Trico Fuses are approved by the Underwriters Laboratories, Inc. Hydro-Electric Power Commission of Ontario, Canada.

TRICO
RED SEAL FUSE PLUG
(Powder-filled)

Light — Compact
100% Positive Indicator
WRITE FOR SAMPLES

THERE'S a reason why Trico Renewable Cartridge Fuses eliminate four-fifths of the blow-outs—save four-fifths of the time men and machines are idle for fuse renewals—cut the number and cost of renewal links required 80%.

Trico Fuses are powder-filled

Each Trico renewal element is a fuse in itself—a cartridge containing a fusible strip surrounded by an arc-choking powder that smothers the flame and absorbs the heat, absolutely preventing burning of the contact points. Because of this improved construction Trico Fuses carry starting and momentary overloads and still give adequate protection against prolonged overloads.

Send for descriptive literature. Or write us on your business letterhead for a test fuse of the capacity you use most. Then you can judge for yourself.

An exceptionally attractive proposition is now being offered to electrical supply jobbers and distributors in territories where we are not represented. Send for it to-day.

Trico Fuse Mfg. Co.
Dept. 19, 143 University Ave., Toronto, Canada

TRICO REG. U.S. PAT. OFF. Renewable Cartridge FUSES

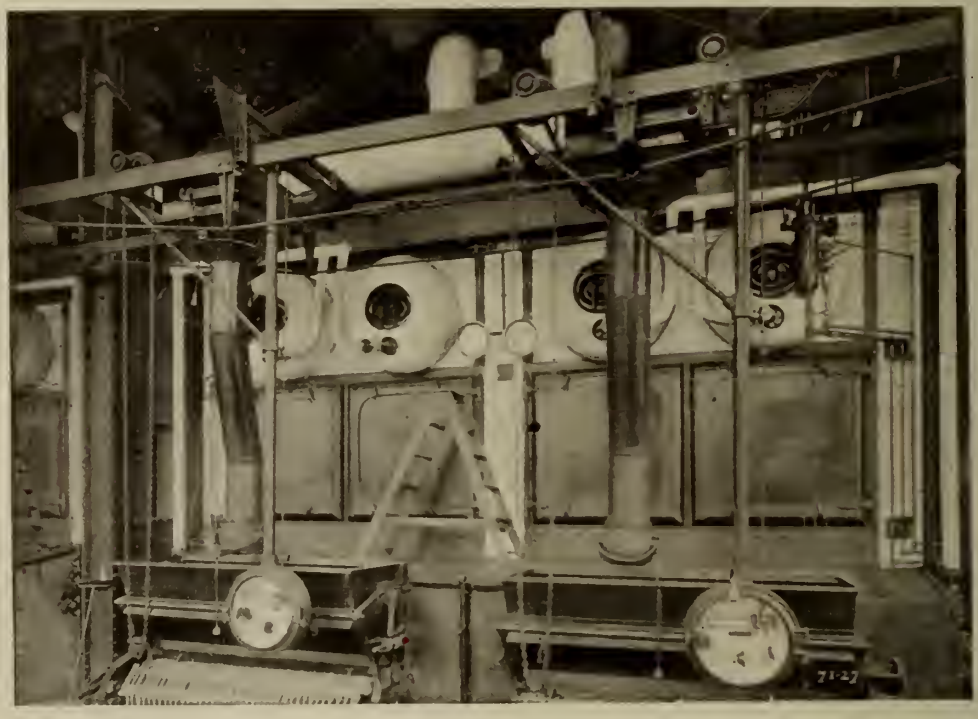
If you knew what we know, you would use them.

"MEAD-MORRISON"

CANADIAN MM Co

Travelling Weigh Hopper

CANADIAN MM Co



Keep a check on your coal consumption. "MEAD-MORRISON" Travelling Weigh Hoppers weigh your coal with the greatest speed and efficiency.

Made in capacities up to 2,000 lbs. Travelling Weigh Hoppers in sizes up to 40 tons.

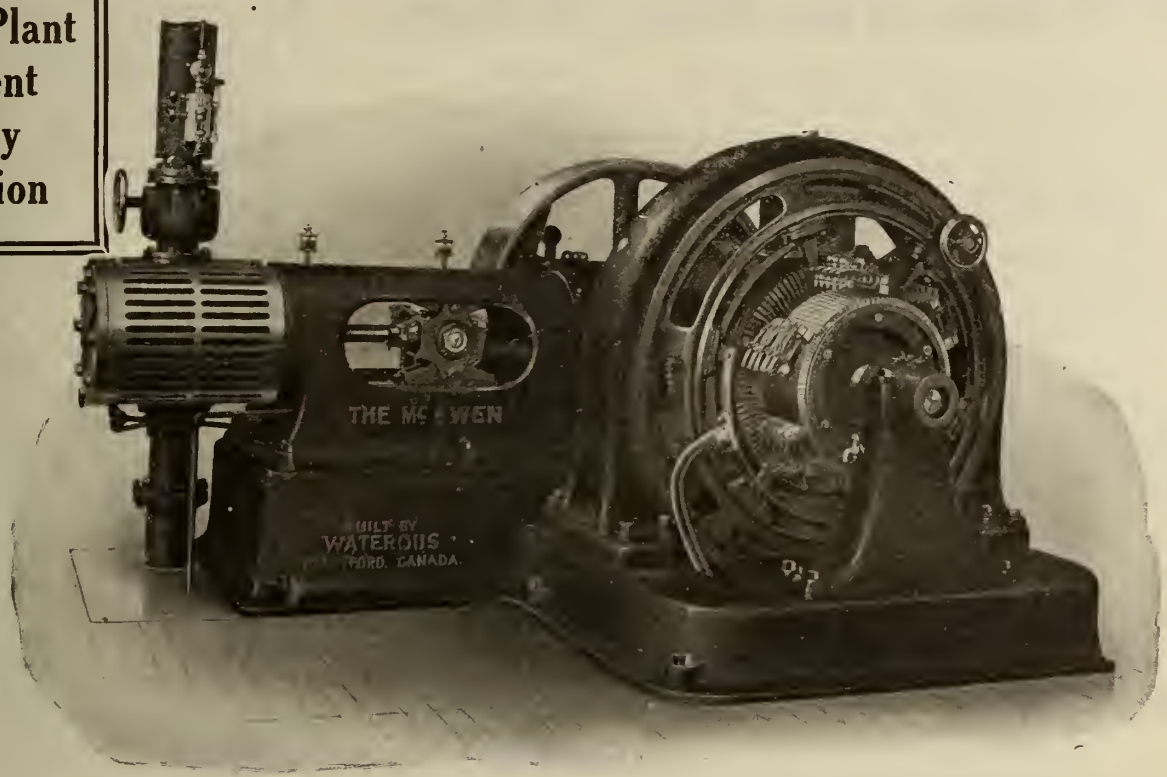
McCaslin Gravity Bucket Conveyors.
Coal Crushers—double or single roll.
Cut-Off Gates.

Agents:
Kelly Powell, Winnipeg.
Robert Hamilton, Vancouver.
Harvard Turnbull, Toronto.
Ferguson & Palmer, London, Eng.

Manufactured in Canada by

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS: WELLAND ONT.

We Build Complete Power Plant Equipment for Every Installation



McEWEN HIGH-SPEED AUTOMATIC ENGINES

These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

Your careful investigation of their actual service performance record in all parts of the country especially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

Waterous

BRANTFORD, ONTARIO, CANADA

The Study of Bailey Charts Will Save You Many Dollars

Bailey Fluid Meters accurately indicate, record and integrate steam flow at all pressures and temperatures without constant recalibration or repairs.

They are a real necessity in determining the steam consumed by the main power generating units, the auxiliaries, the heating and drying system, special process work by the various factory departments and by outside users of steam.

Study Bailey Charts. The elimination of even slightly abnormal operating conditions may mean the saving of many dollars in coal and labor.

Write for bulletins.

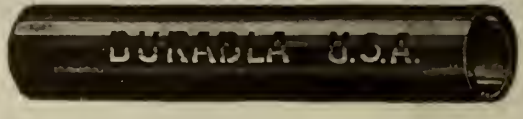
Bailey Meter Co.

2001 E. 46th St., Cleveland, Ohio, U.S.A.

DURABLA

TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on 

Every Glass

TESTS OF HIGH PRESSURE GAUGE GLASS

Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

Tensile Strength—Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.

Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

A-810

Made of Steam Metal

This is a very dependable and durable stop cock. It is made from high-grade steam metal and is favorably known all over Canada.

Our rigid factory tests and guarantee fully protect engineers who recommend them for use. So, for your own protection and the customer's satisfaction you should recommend

Empire Stop Cocks

Complete Empire lines are carried in stock by leading jobbers throughout Canada.

"If it's an EMPIRE Product you know it's right"

Empire Brass M'f'g. Co., Limited

London and Toronto, Canada

New Truths and Old Fallacies

Hardness of Alloys—*Continued*

We have referred several times to the compression test of alloys made by the American Society for Testing Materials, and we give the figures below:

FORMULA					Deformation of Cylinder 1¼" dia. x 2½" high at 70° Fahr.	
No.	Copper	Tin	Anti mony	Lead	At 1,000 lbs. in²	At 5,000 lbs. in²
1	4½	91	4½	..	0.0000	0.0010
2	3½	89	7½	..	0.0000	0.0015
3	8 1-3	83 1-3	8 1-3	..	0.0010	0.0045
4	3	75	12	10	0.0005	0.0025
5	2	65	15	18	0.0010	0.0030
6	1½	20	16	63½	0.0015	0.0050
7	..	10	15	75	0.0010	0.0050
8	..	5	15	80	0.0020	0.0090
9	..	5	10	85	0.0040	0.0120
10	..	2	15	83	0.0010	0.0100
11	..	..	15	85	0.0010	0.0100
12	..	..	10	90	0.0025	0.0170

In analyzing these figures it should be remembered that metals have no ultimate crushing strength, as they spread when the load goes beyond a certain point; also that tin base metals are more resilient than lead base metals and that the former will resume their original form, partially or altogether, when the pressure is removed, whereas a lead base metal will become permanently set under a comparatively light load, and the value of the above figures are somewhat dependent upon whether measurements were made before or after the load was removed. This thought was suggested by the apparently anomalous difference shown between formulas Nos. 1, 2 and 3. If formulas 1 and 2 did not resume their original form under the 1,000 lbs. pressure and partially resume it under 5,000 lbs., then all preconceived ideas are upset as to the value of copper as a hardener, as shown by comparison with the No. 3 formula, which contains a greater quantity of both copper and antimony.

(Continued next month)

For copy of complete article:
"New Truths and Old Fallacies"
Address our Montreal Office

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OF CANADA, LIMITED
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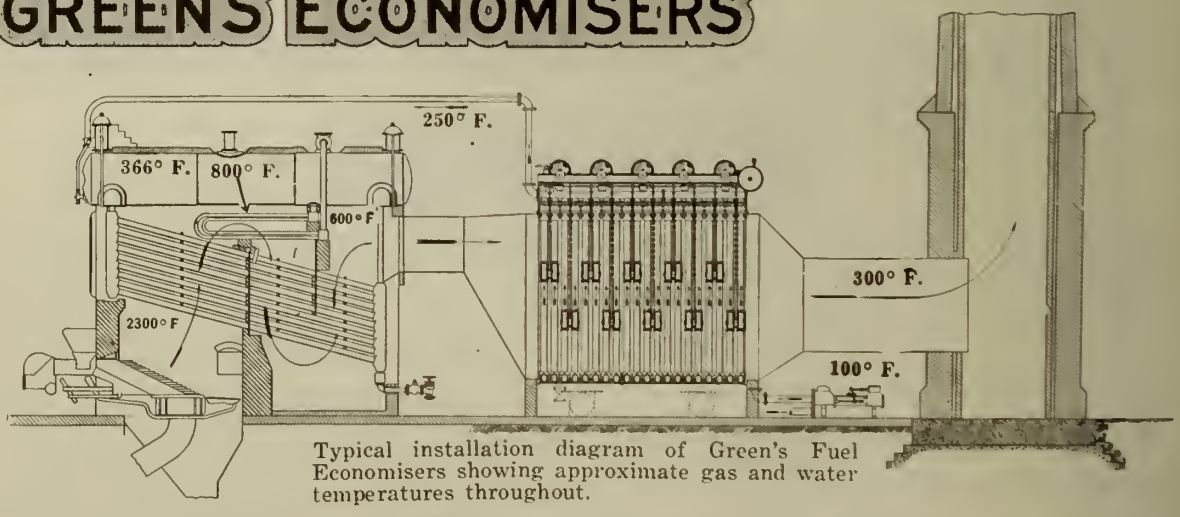
Montreal: 37-39 Shannon St.

GREEN'S ECONOMISERS



Typical installation diagram of Green's Fuel Economisers showing approximate gas and water temperatures throughout.

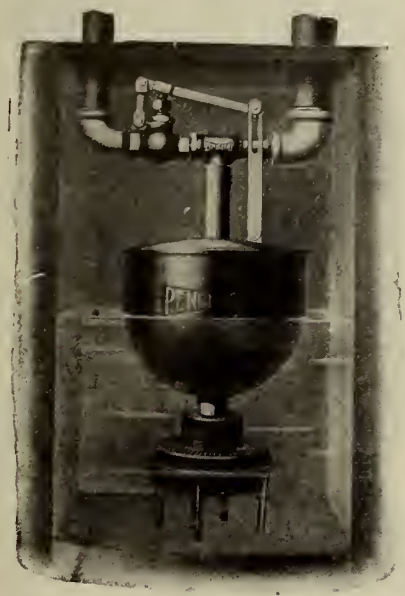
At the recent Chemical Exposition in New York, during the fuel economy conference, one of the speakers, a noted engineer, stated that by far the greatest heat loss in the boiler room was in the sensible heat of the exit gases.

The use of extra boiler surface to cool gases below 500° F. does not pay because below 500° F. the heat absorbed per square foot of heating surface does not equal the cost of maintenance. The use of **Green's Economiser** is the most economical method for recovering this loss—it will reduce the gas temperature to a low figure at minimum cost—by transferring the heat of the gases to the feed water, under boiler pressure, thus allowing the boiler to be supplied with water at a temperature slightly lower than the steam itself.

Write for our bulletin No. 151, or call for one of our engineers to inspect and make recommendations for your conditions.

GREEN'S ECONOMISER, LIMITED.
TORONTO

TRADE PENBERTHY MARK.



Illustrating Penberthy Cellar Drainer Installed in Pit or Sump.

AUTOMATIC CELLAR DRAINER

ALL WORKING PARTS ABOVE WATER

LOOK OUT

FOR THE SPRING FLOODS!

Keep Your Basements Dry

There is no excuse for flooded basements or cellars when the Penberthy Cellar Drainer will keep them dry and sanitary.

WHAT IT IS FOR AND HOW IT IS OPERATED

A device for transferring liquids from one level to another with water under pressure or steam as power. The name Cellar Drainer is derived from its commonest use, that of pumping water from cellars, but its utility is not necessarily restricted to this usage. The construction of the Penberthy Automatic Cellar Drainer is admirably simple, being a highly efficient ejector or syphon jet to which is attached a quick-opening, float-controlled valve. Nor is there anything complicated about its operation. The Drainer is placed in the sump or place where the water or seepage collects, a line from the city water supply attached at one side and a line leading to your discharge point (sewer, gutter or wherever it may be to the other side. Then turn on the water and forget it, for as the water rises in the pit the float is raised, and when the right height is reached the valve is opened instantly, allowing the city water to flow through the ejector, cause a suction, and carry the sump water with it to the discharge. As the water goes down the float follows and when the low point is reached the valve closes, to remain closed until enough water collects to again raise the float, when the whole operation is repeated.

Stocked by Leading Plumbing and Heating Jobbers.

Write us for Descriptive Circular.

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

It Brings Returns

in money saved, in coal saved, in time saved to invest in

PLIBRICO
JOINTLESS

FURNACE LINING

A furnace lining full of joints means loss of money through loss of heat and rapid deterioration. There are NO joints in a PLIBRICO lining, therefore no loss of heat —no coal waste—and deterioration cannot start. A PLIBRICO lining is quickly and easily installed, a saving in time. Therefore PLIBRICO is a big-paying investment.

Shipped in steel containers of distinctive appearance as shown at the right. Warehouse stocks in Montreal, Toronto, Winnipeg, Vancouver and Calgary ready for immediate delivery.

Ask for book on Furnace Building.

JOINTLESS FIRE BRICK CO.
1130-1150 Clay Street, Chicago, Ill.

IT JUST

PACKS and PACKS and PACKS and
PACKS and PACKS and PACKS and
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PACKS and PACKS and PACKS and

AMBEST FLEXIBLE METALLIC PACKING

EVERY SIZE NEEDED IN SAME CAN

MILL SUPPLY DEPT.

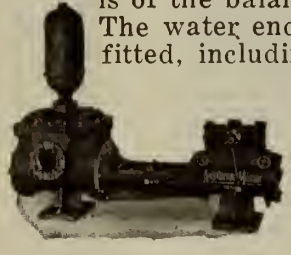
Beveridge Paper Company Limited
MONTREAL

AMERICAN-MARSH PUMPS

SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—
Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

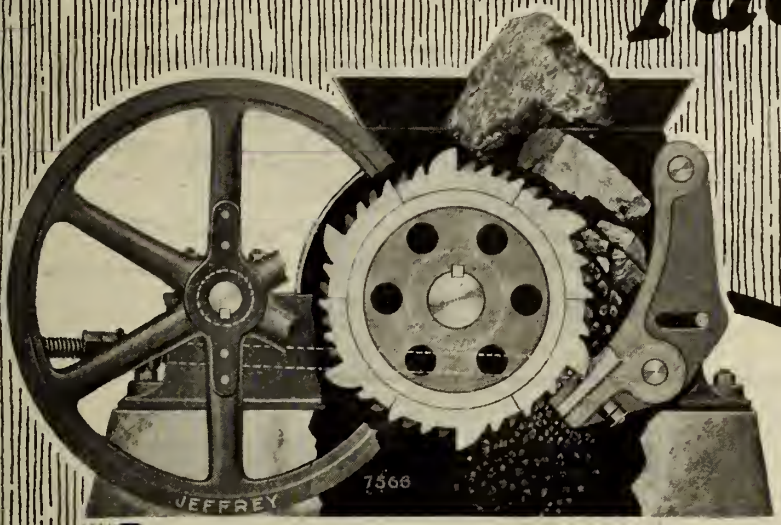
Ask for General Catalog

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London, Ont. Gorman, Clancy & Grindley, Limited, Edmonton, Calgary and Vancouver.

Power plant efficiency = 100%

Factor of Safety = ?



PATENTED

Your plant may be functioning at top-notch speed—there may be close co-operation, scientific management, large output, quick deliveries, and everything operating at the highest efficiency, but at the very minute you may be working under a peak load you suddenly find yourself deprived of a supply of stoker coal and your whole system goes to smash.

You have overlooked the Factor of Safety.

A Jeffrey Single Roll Crusher

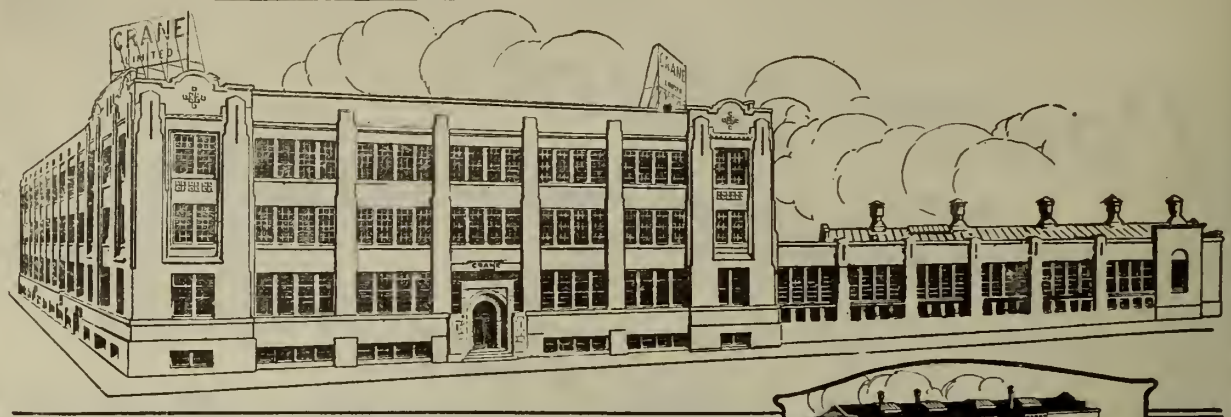
installed in your power plant means a real, lasting and dependable Factor of Safety.

It crushes run-of-mine or lump coal to stoker size in one operation and makes your plant independent of Mine, Weather and Traffic Conditions.

Write to-day for copy of Bulletin No. 141-4.

SHIPMENT FROM STOCK

The Jeffrey Mfg. Co.
Canadian Branch and Warerooms
MONTREAL



View of Plant from Rear

Garage and Stables

CRANE
LIMITED

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

The establishment of Works at Montreal and Branches (carrying complete stocks) in other principal Cities of Canada enables us to give "CRANE" service and quality throughout the Dominion.

CRANE Quality — Any Purpose or Pressure

Cast Iron Fittings, Screwed and Flanged.
Malleable Iron Fittings.
Cast Steel Flanged Fittings.
Forged Steel Screwed Fittings and Flanges.
Unions and Flange Unions. All iron, all brass, brass to iron.
Brass Fittings, Screwed and Flanged.
Drainage Fittings.
Valves (brass, iron and steel.)
Power Plant Equipment : Pipe Bends, Flanged and Screwed Pipe.
Steam Specialties.

CRANE Quality

Plumbing and Heating Materials. The last word in equipment for the Home, Factory, Office, or any other type of building.

Branches and Warehouses
Halifax, Ottawa, Toronto, Winnipeg, Regina, Calgary, Vancouver.

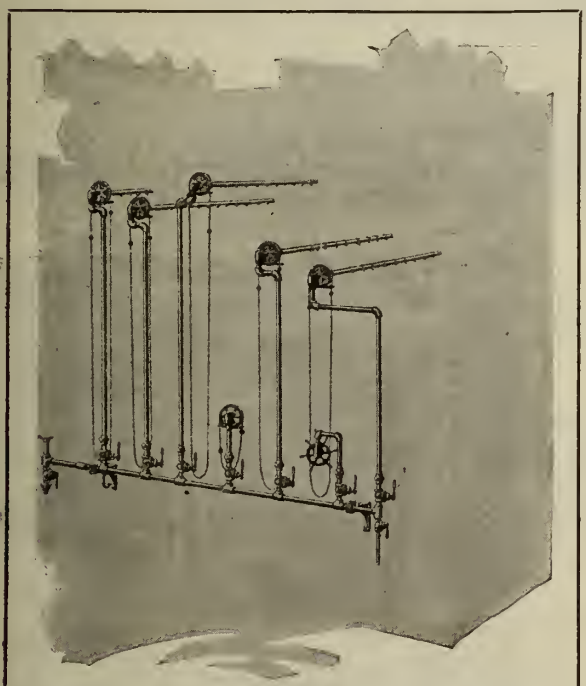
Sales Offices:
Quebec, Sherbrooke, Hamilton, Victoria.

CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST PATRICK STREET
MONTREAL

CRANE BENNETT Limited
Head Office and Warehouse:
London, England.

Sales Offices:
Manchester, Birmingham.

Cleaning Your Horizontal Water Tube Boilers CLEAN!



This illustration shows the Vulcan Soot Cleaner as applied to Horizontal Water Tube Boilers, of the Goldie & McCullloch B. & W., Edge Moor, Keeler, Casey-Hedges, and similar types. Systems of 4, 5 and 6-elements are used for cleaning these boilers, according to size and conditions. As a rule, 6-elements are installed, and sometimes an additional element when a superheater is employed.

SOME manufacturers put off the installation of mechanical soot cleaners because they think this equipment is in the nature of a luxury that can be dispensed with more or less indefinitely.

Were more of these men aware that a very large majority of the **Public Service Corporations** of Canada and the United States—concerns which manufacture power FOR SALE! — have their boilers completely equipped with mechanical soot cleaners, they probably would change their point of view.

Vulcan Soot Cleaners are a tangible, dividend-paying investment. This dividend varies from 20% to as high as 200% or more, depending upon the plant, fuel consumption, fuel cost, etc. No plant can purchase Vulcan Cleaners unless it can be reasonably demonstrated, in advance, that they will PAY.

A little while ago, we prepared a "financial analysis" for a concern that has since installed Vulcans. This analysis has been printed up under the heading "SPENDING $796 TO EARN $1,017.40!' If you are interested in the possible financial advantages that you may derive from Vulcan Soot Cleaners, we shall be glad to send you a copy—of course, quite without obligation. Just write any of our offices listed below.

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES

WINNIPEG
William W. Hicks & Co.,
567 Banning Street.

TORONTO
Green's Economiser, Ltd.,
Kent Building.

Let Riley Stokers Reduce Your Costs

Riley Stokers are always on the job—you can rely on them to be at work every day. They are tireless—working all hours of the day and night —without complaint.

Industrial plants can cut their operating costs to a minimum by using Riley Underfeed Stokers. Consider the following facts:—

EFFICIENCY—Boiler tests on Riley Stokers have shown over-all efficiencies of 80% and higher.

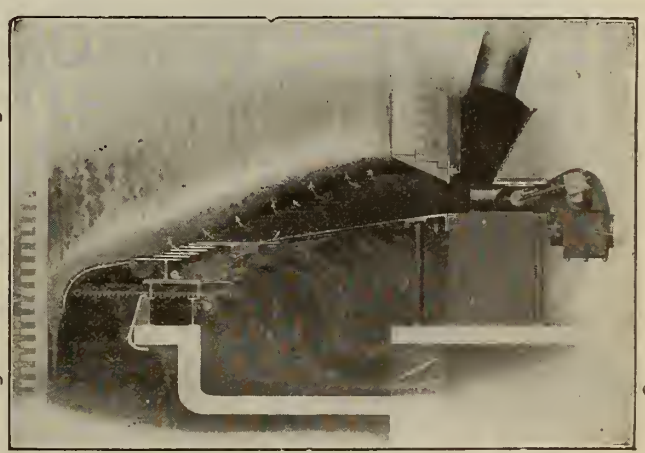
LABOR-SAVING—One or two men can replace ten or twelve required for hand firing. Continuous, automatic discharge of ashes means elimination of drudgery in fire cleaning. Labor for ash handling in a well-laid-out plant is negligible.

COMPLETE COMBUSTION—The underfeed method and moving grates intimately mix the proper amount of air and coal, giving perfect combustion.

Catalog H.R4 sent on request.

For information on the Murphy Automatic Furnace for small plants, see last month's advertisement, or send for Murphy catalog HM-4.

Sanford Riley Stoker Company
Worcester, Mass.



LINDE

Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

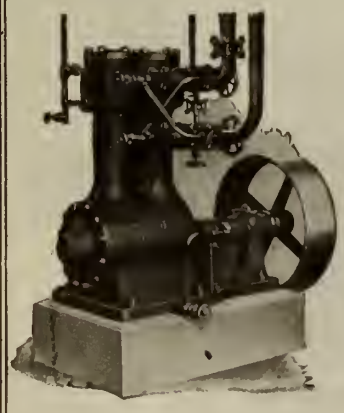
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVE



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

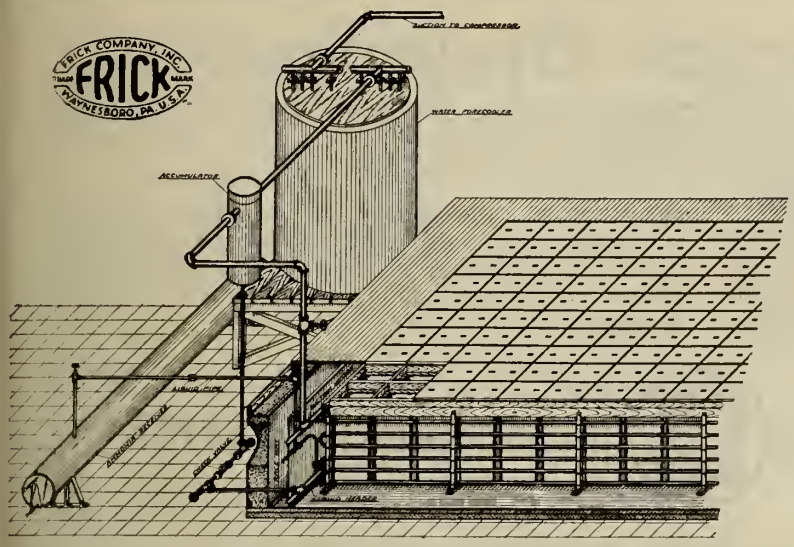
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



The FRICK FLOODED SYSTEM

Is a STANDARD Part of Every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It {
- Simplifies plant operation by reducing the number of feed valves to be regulated.
- Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
- Adds to plant safety by preventing priming accidents.
- Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

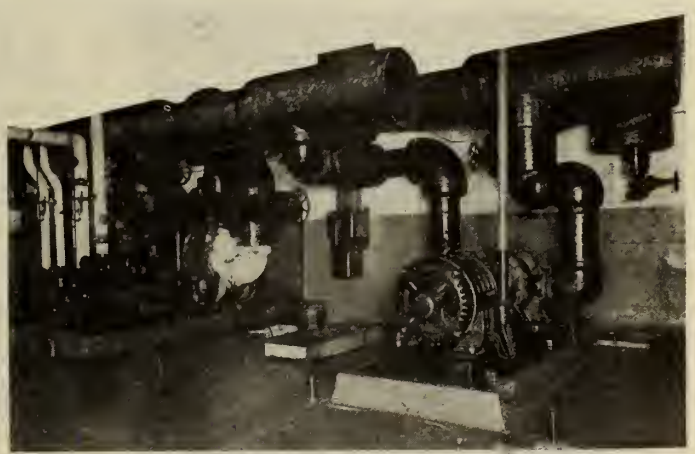
Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Protected All the Way

CARRYING refrigeration to insulated rooms in uncovered lines is a good deal like wearing a shoe on one foot and leaving the other foot bare. Unbalanced operation results in either case. Certainly it is just as essential to protect your refrigeration on the way to its work as it is to conserve it after it gets there.

Even at the same temperature difference, one square foot of bare pipe surface will lose considerably more refrigeration than a square foot of uninsulated brick wall. With brine at 15° F. and air at 75° F., at least *one ton* of refrigeration is lost *every day*, from 120 feet of 3-inch, or 175 feet of 2-inch bare pipe—a total of 300 tons a year, and you know what refrigeration costs you now.

Whether you have 20 or 200 or 2,000 feet of line you can insulate it with Nonpareil Cork Covering for less than the loss from that line in a single year. Nonpareil Cork Covering eliminates this needless waste, once and for all. Afterward, for the many years the covering will last, that saving is clear profit to you.



Refrigeration losses are reduced to a minimum by the use of Nonpareil Cork Covering on these brine lines in the plant of the Loose-Wiles Biscuit Company, New York City.

You can easily figure pipe line savings for your own plant from the tables included in the 64-page book, "Nonpareil Cork Covering." This is a valuable work on refrigeration loss and cold pipe insulation which every manager and engineer should have. Your copy will be mailed on request, without charge.

ARMSTRONG CORK & INSULATION COMPANY, 902 McGill Building, Montreal, Que., Can.
11 Church Street, Toronto, Ont., Can.

Nonpareil Cork Covering

For Brine and Ammonia Lines

The York Service Organization

York QUALITY Products and Expert ENGINEERING Advice are brought into close proximity to every user of Ice Making and Refrigerating Machinery by the York Service Organization.

The close, personal touch afforded by this organization in all our dealings with our customers, and the prompt service we are thereby enabled to render, has contributed in no small degree to the Confidence which the Trade places in York QUALITY Products.

Whether you are thinking of installing a new plant, require engineering advice, or need supplies for your Ice Making or Refrigerating Plant, it will pay you to write our nearest Branch.

MECHANICAL QUALITY YORK SERVICE **REFRIGERATION**

The Trade in the Dominion benefits by the ability and experience of this Organization through four regularly established Service Stations.

Canadian Ice Machine Company

TORONTO
Villiers & Munition Sts., Eastern Harbor Terminals

MONTREAL
324 Craig St. West

WINNIPEG
85 Lombard St.

CALGARY
605 Second St.

YORK MANUFACTURING CO., YORK, PA., U.S.A.

(Ice Making and Refrigerating Machinery exclusively)

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

This Grate Must Save You Money!

NONPAREIL

Shaking and Dumping

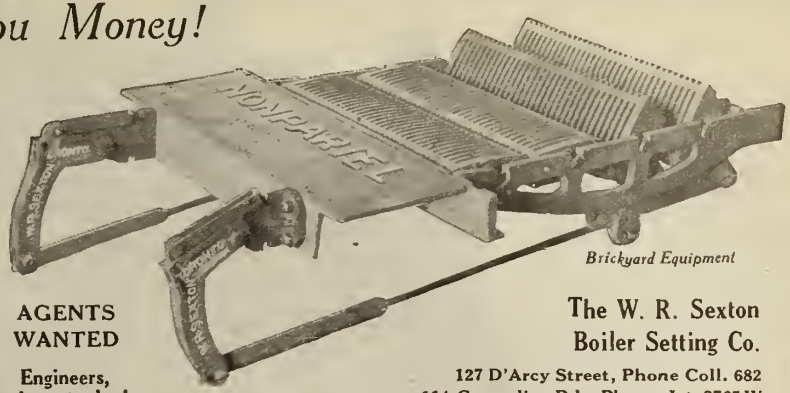
GRATES

must save at least 10% of your present coal bills. They're guaranteed to do this.

The Russell Brickyards, another of Toronto's large brickyards, have just ordered 36 sets.

AGENTS WANTED

Engineers, write us to-day!



Brickyard Equipment

The W. R. Sexton Boiler Setting Co.

127 D'Arcy Street, Phone Coll. 682
114 Grenadier Rd., Phone Jct. 2765 W

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings ***Forgings***

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Blueprints for Quotations. Write for our latest catalogue.

Patterns ***Machine Work***

INVESTIGATE THE

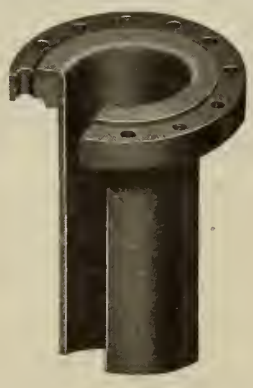
ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

P H FLANGED PIPE JOINTS

SCREWED



P.H. LAP

SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs. the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

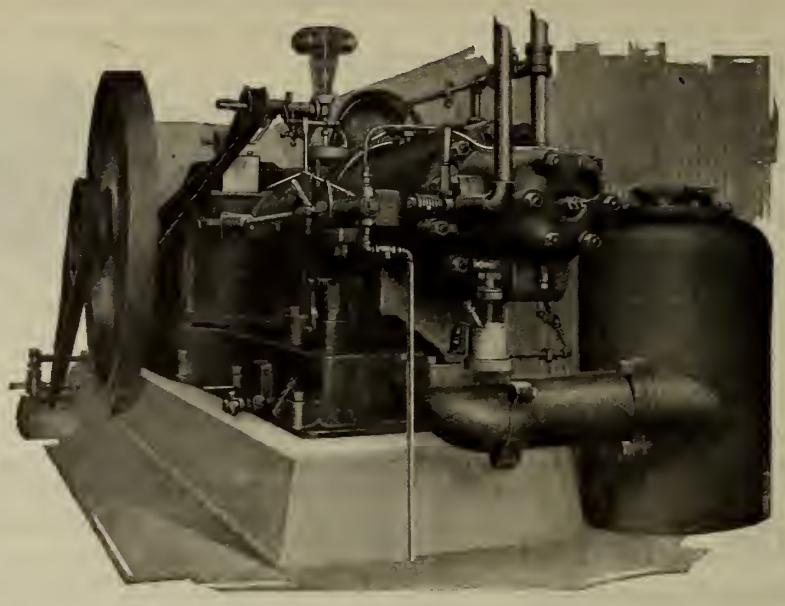
For all High Pressure service, and where it is objectionable to reduce the thickness of the wall of the pipe by threading, we recommend **P H** Lap Joint.

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

100 Church Street, TORONTO, Ont.

J. T. Mays & Bros., Spring Hope, N.C., operate this 50 h. p. Giant Semi-Diesel Oil Engine. Ask this user why he bought a "Giant," or ask us for the location of a Giant Engine installation near *you*.



Giants not only have the fundamentals of economy, low upkeep and long life, but meet every condition of service, no matter how severe or exacting, with either single or duplex types, in capacities from 12 to 200 h. p. Ask for Bulletin 389.

POWER

Additional Power—Replacement Power—Standby Power

Whether dignifying model-of-efficiency power plants or "roughing it" under adverse outdoor conditions, Giant Semi-Diesel Oil Engines can be *depended upon*. Whether installed as additional, replacement or standby power units, you can *rely* upon Giants. Simplicity, economy and certainty of operation are responsible for their wide endorsement by veteran engineers.

Replacement units must necessarily be the sum-total of what the unit they replace *isn't*. Its defects, inefficiencies and unreliability—whether in the form of broken heads, shaft breakage or hard starting due to loss of compression must be overcome by its successor. Giants not only offset undesirable qualities of less efficient units, but in modern points of design they are unequalled.

Standby power has become as much of a necessity in the power field as *plant insurance* — because it stands between the plant operator and shutdowns by insuring a *constant* source of power supply. But only an oil engine of Giant dependability is eligible for this important guard-duty, a duty so well performed that Giants so installed have subsequently succeeded the "regulars."

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

EN 47-H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

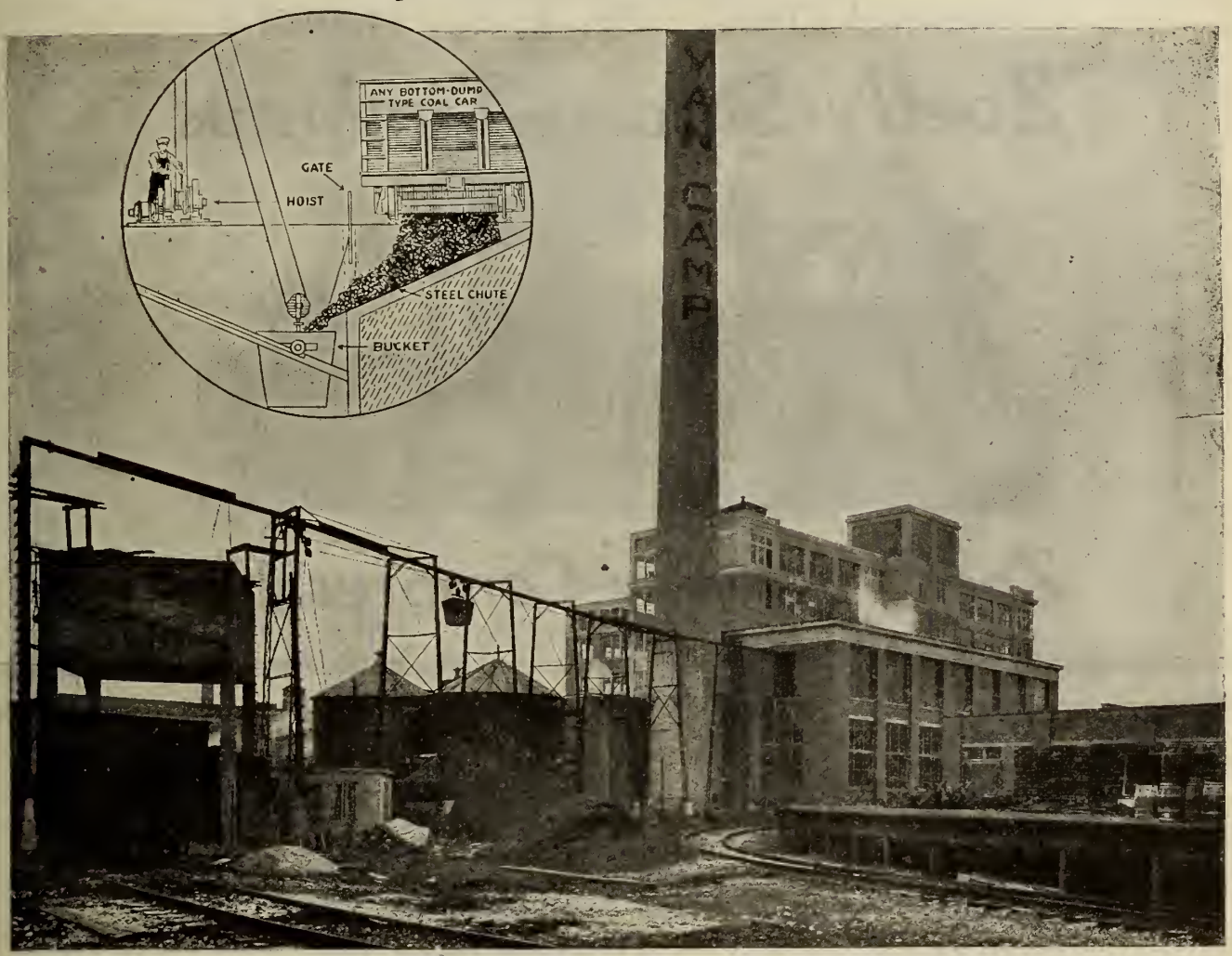
CANADIAN PNEUMATIC

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*

6 Cents Per Ton

For Conveying Coal to Boiler Room



Monorail I-Beam Installation of Von Camp Packing Co.'s Plant

THIS prominent company states that they are unloading from cars to storage at a cost of three cents per ton, while the cost of conveying coal to bunkers in boiler room is only six cents per ton. And all this unloading, storing and reclaiming is accomplished with the service of only one man and a

Godfrey Conveyor

Demurrage charges, embargoes, excessive labor, and handling difficulties are eliminated and cars are released from sidings promptly. By substituting grab hooks for the conveying bucket, Godfrey Conveyors can be adapted to the Handling of Baled Materials, Steel Rails and innumerable other commodities.

Also manufacturers of Godfrey Cableway Conveyors, Godfrey Lumber Conveyors and Godfrey Unloaders.

Write for descriptive catalogue No. D-2.

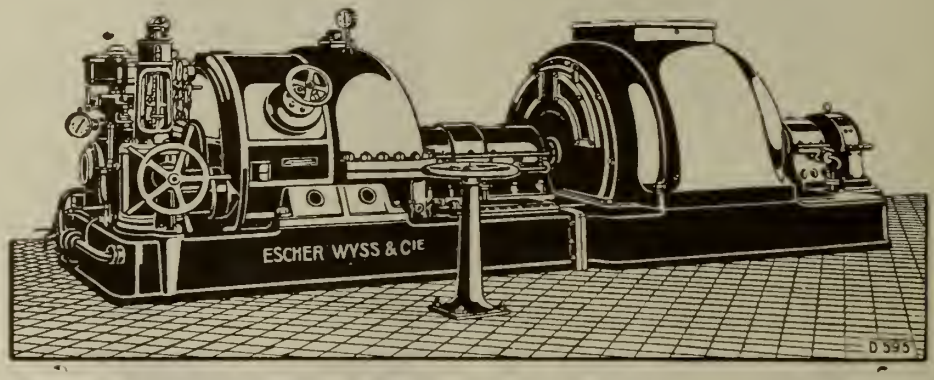
Godfrey Conveyor Company, 127-147 13th Street, Elkhart, Indiana, U.S.A.

REPRESENTED IN CANADA BY M. A. KENNEDY LTD.,
106-110 RICHMOND ST. WEST, TORONTO, ONTARIO, CANADA

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 285 Beaver Hall Hill

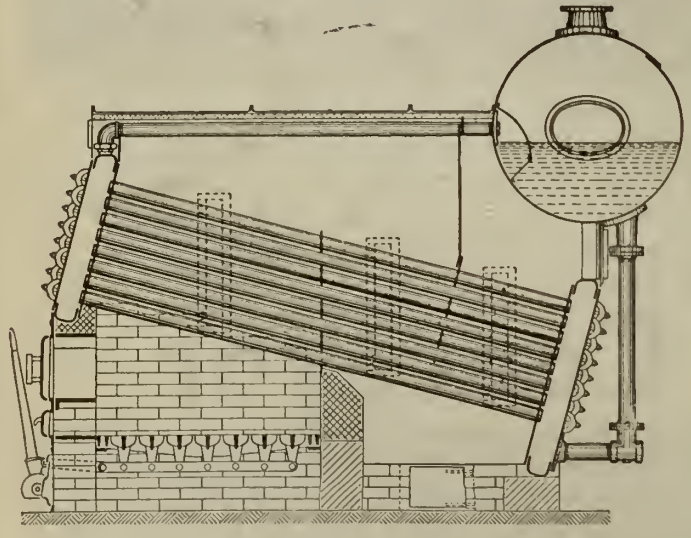
Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

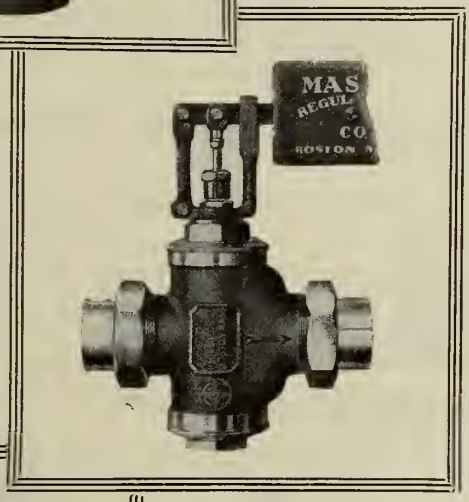
Robb Engineering Works, Limited - - Amherst, N.S.

Montreal Office:
16 Cathcart Street

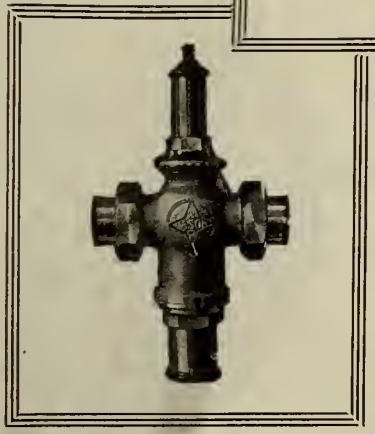
Toronto Office:
20 Victoria Street

You Expect More From MASON APPLIANCES

Mason Standard Reducing Valve, Iron Body



Mason Balanced Valve. Weight and Lever Style.



Mason Standard Reducing Valve, Bronze Body.

The wear-resisting qualities, accuracy and scientific construction of Mason Valves and Regulators entitle you to expect service better than from ordinary valves. Mason Appliances are the universal choice of thousands of power users.

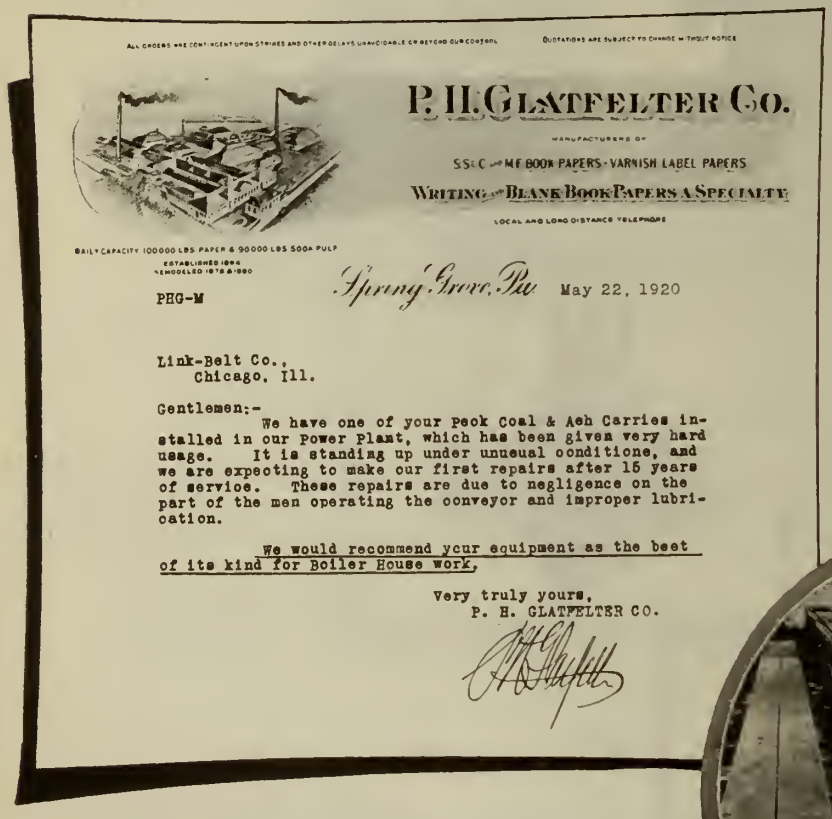
The Mason Regulator & Engineering Co., Limited
MONTREAL TORONTO

VALVES FOR ALL PURPOSES **MASON** REGULATING APPLIANCES

15 Years' Service Without Repairs

THE Peck Overlapping Pivoted Bucket Carrier is the recognized standard machine for handling coal and ashes in the modern power plant. It is the highest development of the conveying art.

The reliability of the Peck Carrier is due to the correct design of the entire machine, the correct principle upon which the design is based, and the rugged, sturdy construction of all parts entering into it.



ALL ORDERS ARE CONTINGENT UPON STRIKES AND OTHER DELAYS UNAVOIDABLE OR BEYOND OUR CONTROL. QUOTATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

P. H. GLATFELTER CO.

MANUFACTURERS OF

SSE & ME BOOK PAPERS - VARNISH LABEL PAPERS

WRITING & BLANK BOOK PAPERS A SPECIALTY

LOCAL AND LONG DISTANCE TELEPHONE

DAILY CAPACITY 100000 LBS. PAPER & 90000 LBS SODA PULP

ESTABLISHED 1864
REMODELED 1878 & 1900

PHG-M

Spring Grove, Pa. May 22, 1920

Link-Belt Co.,
Chicago, Ill.

Gentlemen:-

We have one of your Peck Coal & Ash Carries installed in our Power Plant, which has been given very hard usage. It is standing up under unusual conditions, and we are expecting to make our first repairs after 15 years of service. These repairs are due to negligence on the part of the men operating the conveyor and improper lubrication.

We would recommend your equipment as the best of its kind for Boiler House work,

Very truly yours,
P. H. GLATFELTER CO.

The accompanying letter is not unusual—we have numerous records of performance which we shall be glad to show interested parties on request.

This illustration shows a modern installation of the Peck Carrier.

Let our experienced engineers co-operate with you in planning your coal and ashes handling system.

Send for catalogs.

CANADIAN LINK-BELT CO., LTD.

TORONTO - - WELLINGTON AND PETER STS.
MONTREAL - - - - 10 ST. MICHAEL'S LANE

683

LINK-BELT

COAL AND ASHES CONVEYORS

How long will this Fire Brick last?

Much depends on what's on the trowel

THE life of a fire brick depends largely upon whether the intense heat and flame come in contact with only its face, or with its face, edges and parts of its four sides, which are supposed to be protected by the bond in which the brick was set up.

If the face alone is subjected to the heat, the brick itself conducts that heat away—uniformly.

If the edges and parts of the four sides of the brick are subjected to heat, the brick becomes "heat soaked" and the result is the cracking off or spalling of the surface.

If the sides and edges of the brick are permanently protected, it will last longer—and if all parts, including the face, are protected, it will last still longer.

Therefore, we say that the life of a fire brick depends largely upon what material is used as the bond in which the brick is set.

Unless a bond that will resist expansion and contraction is used, it will crumble and fall out. Unless a bond that will resist high temperatures is used it will melt out.

In either case, edges, corners and parts of the brick other than its face will be exposed.

Johns-Manville Refractory Cements resist expansion and contraction without crumbling or falling out and resist extremely high temperatures without melting and running out. They provide a permanent bond around the sides of the brick, preventing anything but the face from being attacked.

The face itself may be protected by the application of a Johns-Manville Refractory Cement that not only has high heat resisting value, but also prevents the penetration of clinkers into the body of the brick. When clinkers are sliced off brickwork protected in this manner neither the face or any other part of the brick is torn away with the clinkers.

CANADIAN JOHNS-MANVILLE CO., LIMITED

Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa Windsor

JOHNS MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

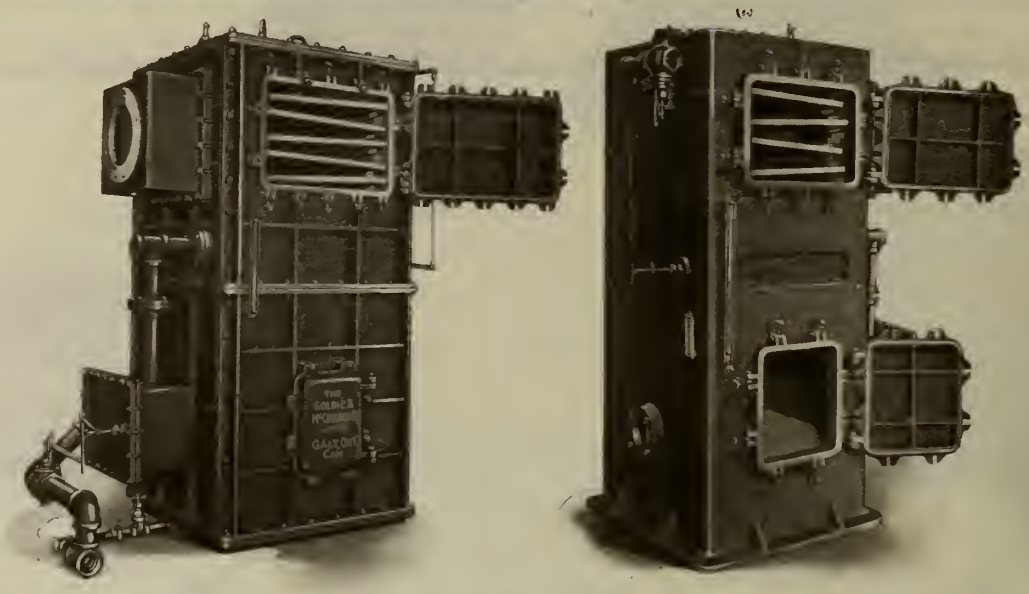
JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE

POWER PLANT MATERIALS

DEPENDABLE POWER EQUIPMENT



Showing the Sectional and Solid Types of Goldie & McCulloch Cast Iron Open Feed Water Heaters

Cast Iron Open Feed Water Heaters

We Build

Steam Engines, Steam Turbines, Return Tubular and Water-Tube Boilers, Heaters, Tanks, Stacks, Centrifugal Pumps, Boiler Feed Pumps, Jet and Surface Condensers.

They form a combination of Feed Water Heater, Purifier and Oil Extractor of the Open or Exhaust Steam Type and will most effectively extract oil and grease from the exhaust steam.

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POWER HOUSE

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Some Results With Mechanical Soot Blowers

This Article Considers Some of the Most Recent Tests With Coal, Pulverised Fuel, and Oil—Marked Increases in Boiler Efficiency With Each of These Fuels.

By ROBERT JUNE

SOOT, it has been stated, is the best heat insulator known, being more than five times as effective as asbestos in preventing heat transference. Those of us who have to deal with the soot problem continuously know that this statement is literally true. You can no more expect efficiency out of a boiler, the fire surfaces of which are coated with soot, than you can expect efficiency from a man with a bad cold. There is congestion and bad circulation in both cases.

If you want to keep up steam when the soot piles up you will have to pile in more fuel. This fact has been strikingly illustrated in some recent tests. Mechanical soot blowers were installed on boilers fired with coal, pulverized fuel and fuel oil. These tests show clearly that clean tubes—clean as only mechanical soot blowers can make them—are absolutely essential to the maintenance of high boiler efficiency.

In this article then, instead of discussing the advantages and disadvantages of mechanical soot blowers — questions which center in the design and construction of the equipment—we will deal with some of the actual results secured in typical power plants, and will reserve our consideration of mechanical features and the types of equipment for different boilers until next month.

Test At Large Railroad Shop Boiler Plant

During the winter of 1918-19, one of the big American railways decided that the cost of producing power at one of its large shops was excessive, and that the posssibility of effecting a reduction through the medium of mechanical soot blowers should be thoroughly investigated.

Bigelow-Hornsby boiler No. 544 in the west boiler-room, which was selected for test, is rated at 625 horse-power. The stoker under this boiler is a Taylor 7-retort underfeed type, having a grate area of 105 square feet, with inclined grate. Forced draft was supplied to this stoker by 1 to 3-inch Sturtevant turbine-driven, multivane, double-inlet fans.

In this test, the forced draft and the stoker drive were separated and the stoker was driven by one of the Westinghouse engines recently installed on the boiler room floor for the driving of stokers. Induced draft was obtained by means of fans located at the uptake to the stack.

On boiler No. 544 steam flow was obtained by means of two meters, one an integrating-recording-indicating General Electric meter, already installed and used in tests, and the other a newly-installed Bailey boiler meter. Weight of coal was obtained from the travelling weight hoppers and lorry tickets. A revolution counter was placed on the Taylor stoker to count the revolutions of the main power shaft. The thermometers for obtaining superheated steam temperature and that for obtaining feed water temperature were placed in thermometer wells in their respective pipes at the top of the boiler, as in previous tests.

Uptake temperature was obtained from three pyrometers inserted into the flue above the damper, and inserted at 4, 5, and 6 feet respectively. The cold junction temperature was obtained by means of an indicating thermometer suspended over the cold junction of the pyrometers. Steam pressure was obtained from the steam gauge in regular service on the drum. A steam correcting thermometer for obtaining the superheated steam temperature corrected was used. The carbon dioxide of flue gas was obtained by means of a sampling tube already installed and used in previous

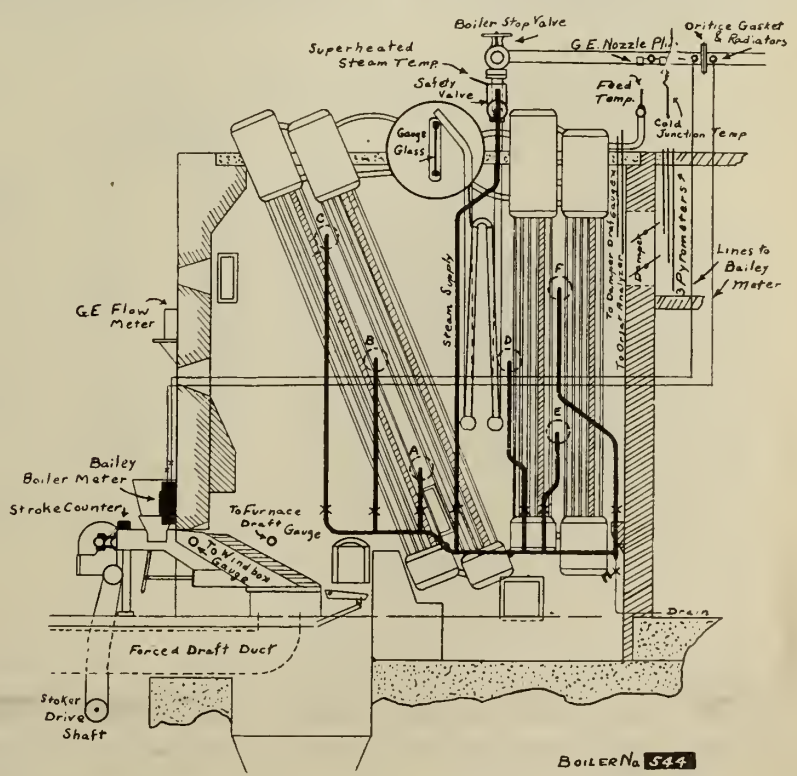


FIG. 1—BIGELOW-HORNSBY BOILER SHOWING LOCATION OF RECORDING DEVICES

tests in conjunction with a standard Orsat gas analyzer. Draft over the furnace and at the damper was obtained on the indicated gauge. Presssure in the wind box was indicated on the lower gauge and in the recording pressure gauge. In addition to the above, the Bailey meter indicated the draft over the furnace and the air flow through the boiler, the latter being obtained by means of 1½-inch pipe connections, one to the combustion chamber over the furnace and the other in front of the damper at the same height as the first. The various items indicated above, and constituting the testing apparatus of this boiler, are shown in the accompanying sketch.

Boiler No. 544 was cut in on the line at 5 a.m., February 3, 1919. The duration of each run was 24 hours. At the beginning of each run the fire was cleaned and the hopper filled. The tail gate was cleaned whenever found necessary by observation of the fire. This varied from about every two to four hours, depending on the load. On this boiler, eight tests in all were made, the first four being with soot blowers, and the second four being without soot blowers, attempting to reproduce the conditions of the first four as nearly as possible.

In doing this the fire-room crew and the tester were guided by the average conditions attained in the first four runs. Readings were taken every 20 minutes. The steam utilized by the soot blowers was not registered by the steam flow meters. Readings were taken as follows: steam flow, air flow, furnace draft gauge, windowbox pressure, the speed of the stoker line shaft, the number of revolutions of the stoker power shaft, steam pressure and carbon dioxide in the flue gas. Forced draft was obtained from No. 3 blower which was isolated from the other blowers by closing the division damper. It was kept running throughout the entire test, and the draft to the boiler was regulated by means of the control at the boiler.

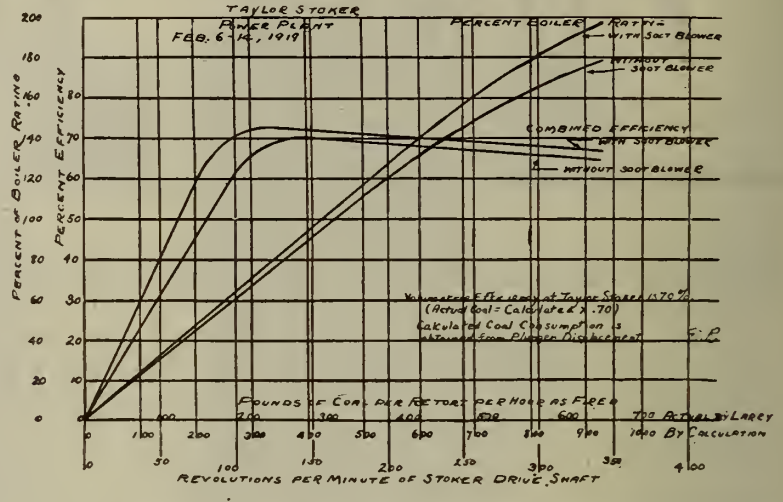


FIG. 2—RESULT OF TESTS ON SOOT BLOWERS ON BIGELOW-HORNSBY

A summary of the principal data and results of the test on boiler No. 530 is given herewith at Table I. The same material has been tabulated for boiler No. 544, but as it does not differ materially, it is not here included.

Average value of the flue gas temperature for the series with soot blowers is 481.0 deg. F., against 569.0 deg. F. without soot blowers. This represents a decrease of 88 deg. using soot blowers, and means that with the soot blowers in operation, the boiler has absorbed more heat from the bases, due to cleaner heating surfaces, than without soot blowers.

It has been stated previously that with the present practice of cleaning the boilers with the hand lance, each boiler is cleaned every four to five days. In the tests on boilers Nos. 530 and 544, without soot blowers, in order to reduce this condition, the series was started with the boiler heating surface clean and then left without cleaning during the series.

If the series had been extended for, say, an equal period or longer, and if during that time the regular hand method had been used to clean the boilers on the regular schedule, it is very probable that a still greater rise in flue gas temperature and still greater decrease in combined efficiency would have resulted. It is safe to say that a more exact test along the line indicated would show better results.

In addition to the above, may be mentioned the fact that operation of soot blowers does not require the banking or shutting down of the boiler, while in order to remove the soot by the hand

TABLE I.

Principal Data and Results of Tests on Babcock & Wilcox Boiler No. 530 with and without the Soot Blowers furnished by the Diamond Power Specialty Co.

Grate Surface of Roney Stoker (width 12 ft. 6 in., length 7 ft. 6 in.) equals 94.5 sq. ft. Total Heating Surface (excluding Superheater) equals 5200 sq. ft.

		With Soot Blower.				Without Soot Blowers.			
		No. 1 Test	No. 2 Test	No. 3 Test	Composite No. 1 to 3 of Tests	No. 4 Test	No. 5 Test	No. 6 Test	Composite No. 4 to 6 of Tests
1.	Date started	†2-6-19	2-7-19	2-8-19	Feb. 6 to 8	2-9-19	2-10-19	2-11-19	Feb. 9 to 11
2.	Duration, hours	24	24	24	72	24	24	24	72
3.	Avg. steam pressure, lbs. per sq. in. gauge	187	187	186.5	.....	187	187	189.0	.....
4.	Temp. of feed water, F. deg.	228	217	223	.....	235	194.5	196	.....
5.	Avg. steam temp. F. deg. corrected	425.3	419.3	421.0	.....	427.3	436.7	445.5	.....
6.	Avg. superheat, F. deg.	43.3	36.8	38.6	.....	45.3	54.2	62.1	.....
7.	Avg. uptake temp., F. deg. corrected	481	479	484	481.0	502.0	583.0	621.5	569.0
8.	Avg. CO2 per cent.	10.9	11.8	12.8	.....	.....	.....	.....	.....
9.	Moisture in coal, per cent.	0.85	0.95	0.50	.....	.....	.....	.....	.....
10.	Total coal fired, lbs.	43430	48070	58500	.....	45105	55350	57540	.....
11.	Total coal, dry, lbs.	43060	47613	58257	148880	44879.5	54918	56948	156746
12.	Dry coal per hr., lbs.	1794.2	1984	2425	.....	1870.0	2288.0	2373.0	.....
13.	Dry coal per sq. ft. of grate, per hr., lbs.	19.08	21.1	25.8	.....	19.89	24.35	25.25	.....
14.	Total actual evaporation, lbs.	349080	412632	472968	.....	381348	441504	427468	.....
15.	Factor of evaporation	1.061	1.069	1.064	.....	1.055	1.102	1.107	.....
16.	Total equivalent evaporation from and at 212 deg. F., lbs.	370024	441102	503238	1314364	402322	486537	473229	1362088
17.	Equivalent evaporation per hr. from and at 212 deg. F., lbs.	15417.8	18379	20968	.....	16763.4	20272	19718	.....
18.	Equivalent evaporation per hr. from and at 212 deg. F. per sq. ft. heating surface, lbs.	2.96	3.53	4.03	.....	3.22	3.89	3.80	.....
19.	Rated capacity per hr. from and at 212 deg. F., lbs.	17940	17940	17940	*1291680	17940	17940	17940	*1291680
20.	Per cent. of rated capacity developed, per cent.	86.0	102.4	116.9	101.7	93.4	113.1	110.0	105.4
21.	Equivalent evaporation from and at 212 deg. F. per lb. dry coal, lbs.	8.59	9.25	8.64	8.83	8.96	8.86	8.32	8.70
22.	Heating value of dry coal B.t.u., per lb.	13572	14123	13840	13865	13731	14073	13996	13940

†Test No. 1 started February 6th at 9.30 a.m. Each succeeding test starts one hour later in the day than the preceding one.
*72 hours.

method it is necessary to shut down the boiler for two or three hours, during which time the boiler setting cools and must be warmed up again. Here is a loss which is eliminated by the use of soot blowers.

In conclusion, it should be noted that these tests were conducted in a manner

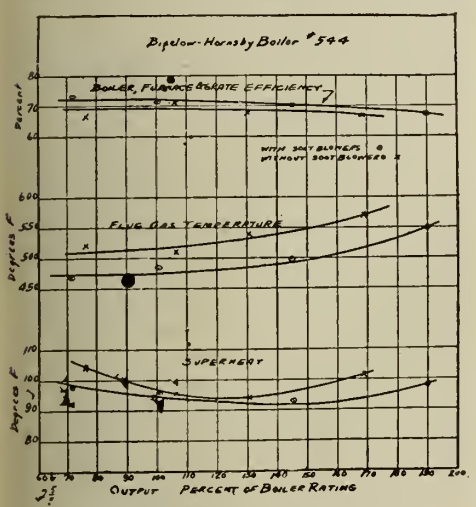


FIG. 3—GRAPHIC SUMMARY OF RESULTS ATTAINED BY USE

calculated to indicate a minimum rather than a maximum improvement by the use of soot blowers. The tests would undoubtedly have been fairer if the use of soot blowers before making the tests had been refrained from, employing the hand lance only to clean the boilers at the regular periods of cleaning. Had this been done, the boilers would not have had the advantage of being cleaned thoroughly by mechanical soot blowers when they entered the hand-hose test.

Mechanical soot blowers are just as important, just as necessary with pulverized fuel as with other types. As a matter of fact, in practically all successful installations, where pulverized fuel is used, the boilers are equipped with mechanical soot blowers. The tubes should be cleaned by the blowers every six hours or oftener. As the temperatures are high, the blowers should be

TABLE II.
Comparison of Composite Results With and Without Diamond Soot Blowers.

	Boiler 530	Boiler 544
Decrease in average uptake temperature with soot blowers, deg. F.	88	36.1
Percentage gain in efficiency of boiler furnace and grate with soot blowers	2.15%	2.05%
Value of savings of coal per year based on 1918 consumption and prices:—		
In West Boiler Room	$ 8,559.86	
In East Boiler Room	5,503.19	
Total saving	$14,063.05	

constructed of some such material as calorized metal in order to withstand the hard surface conditions. The regular use of mechanical soot blowers will save from 4 to 8 per cent. of fuel, as well as a large amount of the labor required for cleaning.

Soot Deposits in Oil Fired Boilers

The soot deposit resulting from the combustion of oil is in the nature of a pure carbon mixed with a slight amount of oil. It is somewhat fluffy in appearance and adheres readily to the tubes, but is easily cleaned and removed from them under the operation of a steam jet. It is entirely different in character from the soot resulting from combustion of coal on account of the absence of ash, etc., and the presence of greater or less quantities of unburned oil, which, going through the boiler, tend to deposit on the tubes in combination with the soot. If this formation is not removed at regular intervals it soon crystallizes or carbonizes on the tube and must then be scraped off with rods or bars.

Soot deposits from oil-fired furnaces have much greater insulating effect than those occurring with coal-fired furnaces. There are two reasons for this: first of all, the deposit is in the nature of a pure carbon which has greater insulating properties than various ash constituents found in soot from coal; second, the deposit being of a somewhat fluffy adhesive nature, is usually found to envelope the entire tube as compared with coal deposit, which usually consists of soot, dust and ashes, building on top of the tube and leaving the underside more or less clean.

For some time after oil came into use for boiler furnaces, the impression prevailed that oil-fired did not require as frequent or as thorough cleaning as coal-fired. The efficiencies of oil-fired boilers were generally higher than those obtained where coal was used as fuel, due to more perfect combustion with a smaller quantity of excess air, and this improvement was for some time accepted on its face value as the best obtainable. With the increasing use of oil as fuel in the past few years, it was inevitable that detailed tests should be inaugurated of the performance of oil-fired boilers with and without mechanical soot blowers.

These tests developed the fact that mechanical soot blowers are absolutely essential to the development of the highest efficiencies on oil-fired boilers. As an example, attention is called to the results of the following test by the Pacific Gas and Electric Company.

TEST DATA BEFORE USING SOOT BLOWERS.

Time A.M.	Stack	Temperature Sup. Steam	Load Meter
10.15	550	500	4.2
10.30	550	502	4.0
10.45	555	498	4.0
11.00	557	498	4.1

TEST DATA AFTER USING SOOT BLOWERS

Time P.M.	Stack	Temperature Sup. Steam	Load Meter
2.30	485	495	...
2.45	485	506	...
3.00	482	504	...
3.15	483	505	...

Test Results	Before	After
Load Meter	4.075	4.175
Per cent. rating, per cent.	101.85	105.38
Steam pressure gage, lbs.	199.5	200.75
Superheater steam temp., deg.	499.5	502.5
Stack temperature, deg.	553	483.75

These results show that the soot blowing caused the temperature of the stack gases to fall from 554 deg. to 483.75 deg., making a difference of 69.25 deg. or 13.05 per cent.

Also the temperature of the superheated steam was raised from 499.5 deg. to 502.5 deg., a rise of 3 deg. or 0.6 per cent.

The direct effect of the use of soot blowers is a saving in fuel of 3.9 per cent.

Texas Company, Port Arthur, Texas, found a saving of 5.5 per cent. fuel by the use of mechanical soot blowers and as a result ordered an equipment for 30 oil-fired boilers. As this company is in the oil producing business its action is particularly illuminating.

These tests were followed by others at some of the large western central stations. On one of them, the boiler, a large Stirling, was taken off the line, and the tubes, superheater, etc., washed clean. The boiler was then fired and an evaporation rate of 37,000 pounds of water an hour and 14 per cent. CO_2 was maintained. At the end of 24 hours the soot blowers were operated and were used for 24-hour periods for the remainder of the test with the equipment. During

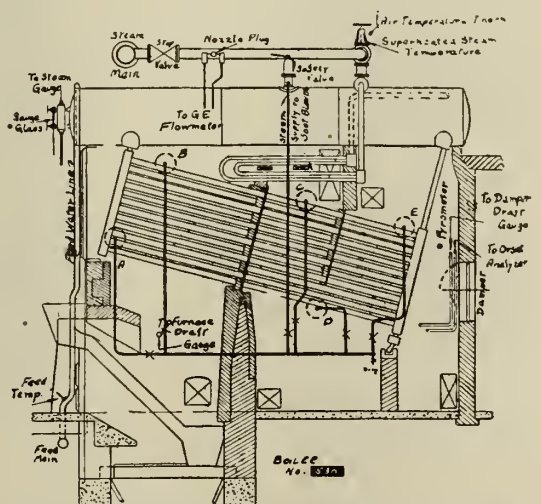


FIG. 4—ARRANGEMENT OF SOOT BLOWER UNITS AND RECORDING APPARATUS ON BABCOCK & WILCOX BOILER.

these tests, readings were taken at 15-minute intervals of the water-rate, CO_2, draft, oil and superheat. When using the blowers, the temperature dropped to 525 deg. and rose to 540 deg. in about 15

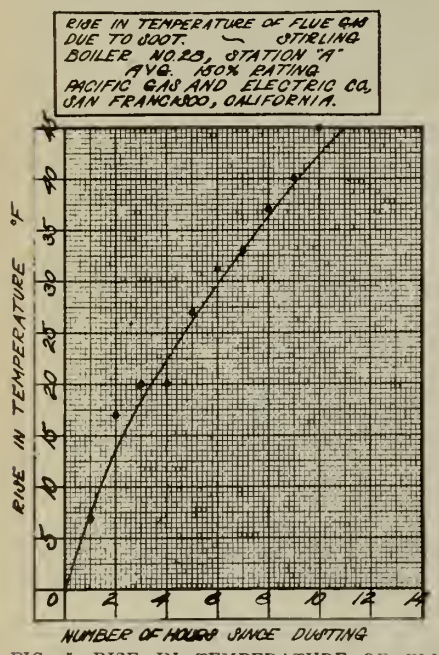

RISE IN TEMPERATURE OF FLUE GAS DUE TO SOOT. — STIRLING BOILER NO 23, STATION "A" AVG. 130% RATING PACIFIC GAS AND ELECTRIC CO, SAN FRANCISCO, CALIFORNIA.
RISE IN TEMPERATURE °F
NUMBER OF HOURS SINCE DUSTING

FIG. 5—RISE IN TEMPERATURE OF FLUE GAS DUE TO SOOT.

minutes. It ranged around 540 deg. for about 16 hours and then crept gradually up to 590 deg. at the blowing period when it again dropped to 525 deg. This was the regular daily performance throughout the test while using the blowers.

At the end of a seven-day period the boiler was given a final blowing and thereafter operated under the usual plant conditions; that is, without any cleaning at all. At the end of the first 24-hours' run, the temperature had risen to 590 deg.: at the end of the week it had risen to 680 deg., and at the end of 10 days had risen to 720 deg., at which point it seemed to hold. But they were not able to maintain the evaporation rate, which dropped to 34,000 pounds per hour. The saving effected by soot blowers amounted to 6 per cent.

Despite the war emergency, with its constant urge to speed rather than thoroughness, the Emergency Fleet Corporation made some detailed tests of Diamond soot blowers before adopting them. These tests were conducted at Burlington, Iowa, under the direction of the Bureau of Mines.

The boiler selected was the Foster Marine water tube, and was one of a large number then being built by the Murray Iron Works of Burlington, Iowa, for the Power Specialty Company of New York, for delivery to the Corporation. The tests extended over a period of a number of weeks and covered a wide variety of operating conditions, with boilers forced to high rating at times, with different conditions and drafts.

In addition to proving the necessity of soot blowers to economical operation, the tests threw some important light on soot blower construction. For instance, in boilers burning fuel oil, draft conditions are very low, running from .02 inch in the furnace up to .08 inch in the uptake. If soot blowers were designed so that all nozzles emitted steam at the same time, a curtain or blanket of steam would be ejected into the boiler at high velocity, with the result that it would either put out the fire or materially interfere with the draft. The bad effects of interfering with the draft can hardly be overstated. As a result of such conditions, all of the factors in the operation of the boiler become unbalanced. This applies to the feed of oil to the furnace, the maintenance of even steam pressure and the injection of the feed water. In place of a normal even operation, a condition of ebb and flow takes place which may last for an hour or more before conditions again become normal. Necessarily, this entails additional work on the part of the fireman who finds the whole routine and operation of the boiler room upset.

In order to take account of this condition, the soot blower for hollow-staybolt boilers is made up in vertical sections, each under the control of its individual valve. This arrangement permits of blowing three or four vertical rows of tubes at one time, thus avoiding all interference with the draft.

On stationary boilers of the horizontal water-tube type, vertically baffled, and on vertical boilers, where revolving soot blower units of the Diamond Model G type are commonly used, the use of fuel oil calls for little change in construction. Care is taken in locating the units to be sure that they blow with the draft. In addition it is sometimes found advisable to stagger, or offset, the blower nozzles so that they do not all blow in the same direction at the same time.

As a result of the Burlington tests hundreds of oil burning vesels, built by the Emergency Fleet Corporation, were equipped with mechanical soot blowers. In conclusion, the mechanical soot blower for oil-fired boilers is here to stay, and the use of blowers on such boilers is fast becoming as common as the use of blowers on coal-fired boilers.

The exact effect of moisture in connection with spontaneous combustion is not known and the evidence of laboratory experiments is contradictory. The repeated wetting and drying of coal seems to increase the tendency to spontaneous combustion. This may be due to the breaking up of the coal which such alternate wetting and drying occasions, even if there is no chemical reaction between the water and the coal. It is not wise to put coal into a pile or to store coal on a damp base if it can be avoided. After a rain or snowstorm, a coal pile should be carefully inspected and watched.

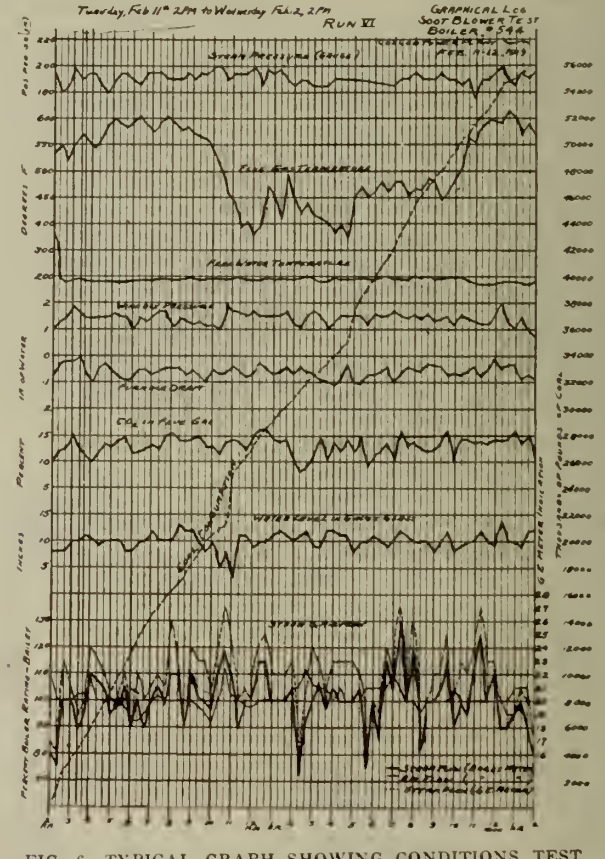


FIG. 6—TYPICAL GRAPH SHOWING CONDITIONS TEST OF SOOT BLOWER.

CATALOGUES.

The Jeffrey Manufacturing Company, Columbus, Ohio, have issued a new booklet describing their standardized scraper conveyors. The booklet is known as Catalogue 257. It is profusely illustrated, and scraper conveyors for practically every conceivable purpose are described. Specifications for ordering, and diagrams showing general overall dimensions, are given.

Toronto No. 1 C.A.S.E. Stage A Real Success

THE Toronto No. 1 C. A. S. E. held their annual banquet at Yonge's banquet hall on March 23. The function was the complete success which we have learned to expect of any effort of this lodge.

About one hundred members, ladies, and guests were on hand when the proceedings were opened by the evergreen "Dad" Wickens. From the time grace was sung till the close of the proceedings at nearly midnight everything went with a swing. No details were neglected, and one gentleman, connected with a famous firm of bricklayers, provided pencils for the guests to take notes with. Much satisfaction was felt in that he had not distributed bricks.

After the excellent dinner had been properly attended to the toast of the King was honored in the only medium now available. Some of the supply men present were heard to complain that ginger ale alone always upset them, but as several of these gentlemen have lived for years in Montreal, nobody took any notice of them.

The first item on the programme was presented by Mr. Howard Fletcher, who played "The Palms" on a one-string violin of home manufacture. He got quite a lot of music out of this unlikely looking instrument, and followed up with "O Promise Me" for an encore.

Mr. C. Mosley, of the examining board, in a short speech introduced to the assembly Mr. W. A. Crockett, one of the original members of the C. A. S. E. and ex-M.P.P. for Labor party. Mr. Crockett, in an exhaustive discourse, reviewed the C. A. S. E. from its inception to the present day, and through its future. He also included a general survey of Toronto, Hamilton, the Province, and the Dominion. The conclusion of his speech was the signal for loud applause.

The Ontario Examining Board was proposed by Mr. Sweet, of Hamilton, and responded to by Mr. James M. Brown, chairman of the board. Mr. Brown, in the course of his remarks, took the opportunity to pay his colleague, Mr. Moseley, a well deserved tribute, which was heartily approved by the audience. Mr. Brown gave a clear account of the board's work, and the aim they had for the future. He said the board intended to make the Ontario first-class certificate the equal of any certificate issued by any other body in the world.

Mr. Bly, of Toronto No. 1, proposed the health of the Grand Lodge, which was responded to by Mr. Ellis, Grand Lodge secretary and member of Hamilton No. 2. Mr. Ellis, in a short and forceful speech, showed what the C. A. S. E. were doing to help out their members in an educational way, and expressed the hope that more advantage would be taken in the future of these opportunities afforded. The Grand Lodge now have a lantern and a large number of instructive slides available for any lodge that applies, and the executive would like to see it used much more than it is. Mr. Ellis spoke of the legislation now on the statute books, and wished it would be more strictly enforced.

The "Supply Men" was proposed by Dad Wickens, and replied to by Mr. Gordon Keith, of "Canadian Manufacturer." During the evening songs were contributed by Mr. Jack Davies, and by Mr. T. H. Fenner, of "Power House."

Some of the guests present were Mr. Gordon Keith, "Canadian Manufacturer"; Stanley Mock, Jenkins Bros.; W. R. Sexton, of W. R. Sexton Co.; Mr. Worthington, of Darling Bros.; Mr. W. H. Auger, of Geo. W. Cole, Ltd.; C. B. Turner; T. H. Fenner, "Power House."

Much credit is due to the organizers of this very pleasant function, and we are sure no one will object to a large share of it going to the energetic old "Dad," whose years continue to sit so lightly on him. The Toronto Lodge can be heartily congratulated on the success of the banquet.

OTTAWA LODGE NO. 6, C.A.S.E.

Ottawa Lodge No. 6 held an open meeting on the evening of March 24th, which was well attended and very successful. The lodge was opened by the officers and members, and after this ceremony the doors were thrown open to the public. A goodly number of engineer non-members availed themselves of the opportunity to hear the lecture on Green's economisers, delivered by Bro. George Lee, boiler inspector for the Provincial Government.

The lecture was illustrated by the lantern belonging to the lodge, the slides being kindly lent for the occasion by the Green Economiser Co. These lantern lectures, of which there have been several during the past winter, have proved very successful, and have resulted in a large number of new members joining the lodge, as well as a number of old members taking up their membership which had been allowed to drop. The executive hope soon to have another open meeting with an illustrated lecture. Arrangements for the annual convention of the association, which will be held in Ottawa on June 28th, 29th and 30th, are well under way, and the officers of the lodge say they will make it a convention to be remembered. They have something up their sleeve in the way of a souvenir, which is confidently expected to put in the shade any previous efforts along this line.

Ottawa Lodge is certainly setting an example to the other lodges worthy of following.

MONTREAL LODGE C.A.S.E.

At the recent meeting of the No. 1 Lodge Montreal C.A.S.E., held on March 24th, an interesting lecture was given by Mr. Evans on the Rees Ro-Turbo Pump. The meeting was as usual well attended, and great interest in the proceedings was evidenced by all present. It is pleasing to note that Montreal Lodge is keeping up its reputation for educational meetings. Some of the other lodges are evidently going to equal, if not exceed, that reputation, as the news from Ottawa and Toronto Lodges would indicate.

MAKING BOILERS SAFE

To operate boilers, and especially water-tube boilers, with safety it is necessary to prevent the water becoming too dense on account of the salts dissolved in it. A continuous means of measuring the density of the water is therefore most important, and it is supplied by a simple "densimeter" invented and manufactured by a British firm. In this appliance a column of distilled water is balanced against a column of water from the boiler, and the difference in the levels of the two columns is a measure of the density of the boiler water. A scale is provided by which the precise difference in levels can be easily read, thus giving the engineer in charge a ready warning when the danger point is being reached. This apparatus has received the approval of the boiler insurance companies.

LARGEST AEROPLANE ENGINE ON RECORD

Great Britain claims the credit of having built the largest aeroplane engine on record. Recently there was tested in a factory near London, England, an engine which developed over one thousand horse power. This engine, which was built to the order of the Royal Air Force, has sixteen cylinders, weighs close on one ton, and is most economical in fuel and oil consumption. Its influence on the range, speed, and carrying capacity of aeroplanes is expected to be considerable, and its performances in the air are awaited with the keenest interest by aviation experts.

The Effect of Load Factor on Station Costs

What Load Factor Is—How the Investment is Affected by Load Factor—Influence of Load Factor on Location of Site—The Selection of Equipment

By PETER JUNKERSFELD

THE annual load factor is an indication of the number of hours per year that the dollar of capital expenditure in a steam station can be kept at work. The expense of using this dollar is just as great when it is working 100 hours as when working the full 8,760 hours of the year. The returns are, however, in direct proportion to the number of hours per year that this dollar is kept at work, or in other words, to the annual load factor. For example, if the annual load factor of a power station is increased from 30 per cent. to 60 per cent. the fixed charges per kilowatt-hour are cut in half.

Load factor is the ratio of the average to the maximum output during any definite period of time. It is usually based upon an average demand for, say, 15 min., and upon output for a day, week, month, or year. It may apply to a system having many generating stations and serving many communities, or merely to one power station or even one unit in a power station.

The annual load factor of a central-station system nearly always changes very slowly. Special effort to secure a well-diversified business together with the new uses of electricity which are constantly arising contributes substantially to improvement in load factor.

The ordinary factory, working a 44-hour week with the usual lay-offs for holidays, keeps a power station busy for only one-quarter of the 8,760 hours per year. Residence and street lighting tend to improve load factor in the summer, but are less and less of a help as the days grow shorter, until they finally change from a blessing to a burden upon the plant, during the months when the lighting peak overlaps the end of the factory or business day..

Investment as Affected by Load Factor

The cost of energy is made up of two principal elements, the fixed charges and the operating and maintenance expenses. In the case of the fixed charges we must use annual load factor because fixed charges run on year after year. Suppose that one power station has cost $100 per kilowatt. At 15 per cent. per annum the fixed charge per kilowatt would be $15 each year. With an annual load factor of 30 per cent., the fixed charge per kilowatt-hour would be 0.57 cent. If the load factor is increased to 70 per cent., we find this fixed charge per kilowatt-hour cut to 0.24 cent.

This comparison, of course, is not wholly a fair one, because a station properly designed to operate at a 70 per cent. load factor would cost more to build, although less per kilowatt-hour to operate, than one of equal capacity but properly designed for a 30 per cent. load factor. Its boilers would have been rated differently, turbines of different individual capacities and perhaps different efficiencies might have been selected, the condensers would have been designed more liberally and higher-efficiency equipment would have been selected wherever economical with the higher load factor. Even supposing that those features boosted the first cost $20 per kilowatt, we would still save probably one-tenth of a cent per kilowatt-hour in the combined fixed charges and operating expenses in comparison with an attempt to impose a 70 per cent. load factor on a plant properly designed for one of 30 per cent.

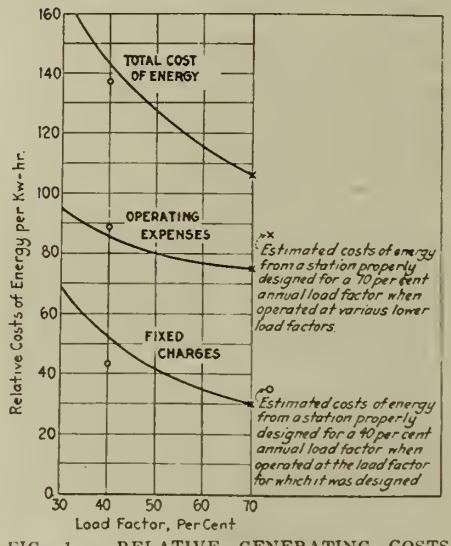

TOTAL COST OF ENERGY
OPERATING EXPENSES
FIXED CHARGES
Estimated costs of energy from a station properly designed for a 70 per cent annual load factor when operated at various lower load factors
Estimated costs of energy from a station properly designed for a 40 per cent annual load factor when operated at the load factor for which it was designed
Relative Costs of Energy per Kw-hr.
Load Factor, Per Cent
0
20
40
60
80
100
120
140
160
30
40
50
60
70

FIG. 1 — RELATIVE GENERATING COSTS, SHOWING THE EFFECT OF DESIGNING A STATION FOR TOO HIGH A LOAD FACTOR.

The curves in Fig. 1 show the relative costs of energy from a power station designed for a 70 per cent. annual load factor when operated at various other load factors. Note at 40 per cent. annual load factor the lower cost of energy obtained from a station designed for a 40 per cent. annual load factor. The lower fixed charges on the 40 per cent. station more than offset its higher operating expenses.

Financial loss will result whenever it becomes necesary to operate a power station at a substantially higher or at a substantially lower annual load factor than the annual load factor for which the station was properly designed. Suppose that the station mentioned previously were one of several stations supplying a light and power system. Assume that at the time of its construction it were intended to operate it on a base load at a 70 per cent. annual load factor, whereas the other stations supplying the system were to be operated only to carry peak loads on account of their inferior efficiency. Assume also that within a few years on account of rapid growth of load another larger station, not previously contemplated, were built having greater efficiency and that the station first mentioned no longer were operated on the base load but were operating at a 30 per cent. annual load factor. We at once see that we are then using an unnecessarily expensive tool where one costing $20 less per kilowatt would do the work just as well and at less total cost per kilowatt-hour.

Similar financial losses may occur in a single power station supplying a rapidly growing load. When a new unit is installed in a power station it is important to know approximately how soon another will be required. Each succeeding unit is frequently larger than the preceding ones, up to the practical limit of size available for the particular purpose. The increased size is usually accompanied by increased efficiency. The units of highest efficiency carry the bulk of the load. The extra price paid for extra efficiency in a power-station unit sometimes results uneconomically due to another larger unit being installed earlier than anticipated.

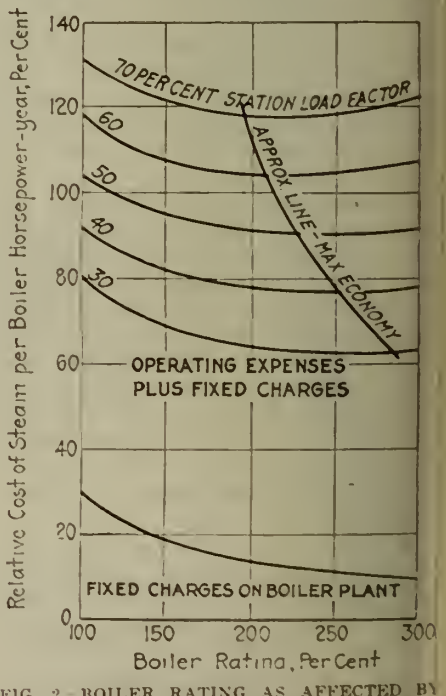


FIG. 2 — BOILER RATING AS AFFECTED BY ANNUAL LOAD FACTOR ON THE STATION

The cost of an error of judgment or the extra expense due to an unexpected change in the annual load factor at which a station or unit is operated may therefore be considerable.

Central-Station Location

The location of a central station relative to its raw-material supply and to the point of delivery of its finished product should be influenced greatly by load factor. In the selection of a site, condensing water is usually given first consideration. Transporting it adds greatly to the station fixed charges, while cooling it artificially causes inefficient operation. A very low annual load factor, likely to prevail over a long period of years, sometimes justifies artificial cooling of condensing water if the station may thereby be located near the load with a minimum investment in transmission lines or cable. With a large annual load factor the additional operating expense due to cooling the condensing water might be so large as to entirely outweigh the fixed charge on the transmission line so that the plant would be located where condensing water is available. In weighing the relative costs, the operating expense at either location must be added to the fixed charge before the more advantageous site can be determined.

Selection of Equipment

Load factor determines the quantity of fuel consumed by a power station and has considerable influence upon the efficiency with which it is burned. Starting, stopping and standing by as well as operating equipment only partly loaded, as is required at low daily load factors, inevitably result in a high coal rate.

One of the first problems, if the station be a new one, is to determine the boiler pressure. High efficiencies can be obtained with high boiler pressure. Construction cost, on the other hand, increases rapidly with increases in pressure. The economical pressure should usually be determined by the extent of the use of the equipment, that is, by the annual load factor.

An arbitrary assumption of steam pressure or an arbitrary selection of certain principal items of equipment may so definitely restrict the design that the full financial benefits of a consideration of load factor in the later selection of additional equipment may not be realized. The most far-reaching power-station engineering is done during the conception of the project, and it is at this time, when fundamental decisions are being made which will either help or hinder the engineering construction and operation of the station, that load factor should be given the greatest consideration. This means not only the immediate load factors but also the load factors that could reasonably be expected during the probable life of the equipment.

Reference has been previously made to the differences in boiler rating for which central-station boiler plants would be designed for operation at different annual load factors. This depends upon the cost of the boilers and combustion equipment, their efficiencies at various loads, the cost of labor and maintenance at various loads, and the fuel required for banking and starting. Fig. 2 shows for a particular case, selected as an example, the effect of load factor on the most economical rating at which boilers should be operated to carry the station peak load. Note the manner in which this economical rating increases as the load factor diminishes.

The rating is only one of a number of boiler-plant problems that arise which must be solved on the basis of load factor. The type and design of the boiler, the length of its tubes, the number of rows of tubes wide and the number of rows high, the combustion equipment, the location of the bridge wall and the baffles, and the size and shape of the furnace, should all be determined by reference to the total load factor on the station as well as the anticipated load factor on the individual boilers. The use of economizers even in large stations cannot be justified at very low load factors.

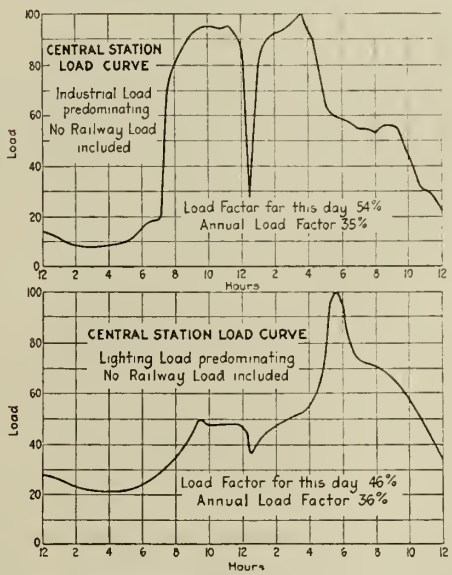


FIG. 3—TYPICAL WEEK DAY LOADS AND CURVES.

The economic selection of turbo-generator units may be made upon the basis of size, speed and other factors. The speed influences both the cost and the efficiency of the unit, and is very important in relation to the average annual load factor at which the machine will operate over a period of years.

The selection of a surface condenser should be made largely from the point of view of the annual load factor. A high load factor anticipated for a unit for a long period of time would justify a condenser of large surface so as to obtain a high efficiency in operation.

The foregoing does not attempt to mention the many power-station appurtenances contributing to higher efficiency which should be omitted from the station designed to operate at low annual load factor, but which might be justified if the station annual load factor were higher. On the other hand, it should not be overlooked that there are some instances in which it is more economical to buy more expensive equipment for low load-factor conditions than for higher load-factor conditions.

The engineers who design a power station fix the upper limit of its operating efficiency by the selection and arrangement of equipment. If this is properly done for the particular load and load factor, the total cost of power from that station, including the fixed charges upon the investment, will be a minimum if the station is properly operated and maintaned. If the selection and arrangement are not made wisely the station thereafter will be handicapped either by excessive fixed charges or excessive operating expenses.

Operating Expenses

The expense of superintendence and station administration is more or less fixed for a given size of station, so that a change of load factor would not influence it in total amount. Boiler labor may be considered as composed of two parts, one of which depends upon the capacity of the station alone, and the other of which, for a station of given capacity, would vary with the daily load factor upon the station. Mechanical labor would be influenced by daily load factor to a less degree, but would depend upon the number and size of the main generator units. The electrical labor would be influenced more by the number of feeders or the number of kinds of current distributed than anything else.

Fuel is usually an item of greater expense than all others and, as pointed out previously, it is dependent upon load factor. Efficiency in the use of fuel is greater at the higher load factors. As an example of the effect of load factor upon station operating expenses, a hypothetical case may be taken of a station containing units of various sizes which might have operating expenses as shown in Table 1. Note the fuel expense as compared wth the total.

Load factor alone does not by any means determine the amount of fuel which a central station of a given size should consume. The shape of the daily load curve is of almost equal importance in its effect upon the efficiency with which the fuel is burned. The shape of the load curve is in turn dependent upon the character of the business served by the central station. This is illustrated by the two examples of central-station load curve given in Fig. 3. In both instances the lighting peak overlaps the day load, but on acocunt of the predominance of factory load in the business of one of these stations an exceptianally favorable shape of load curve is obtained as well as a relatively high load factor for the day.

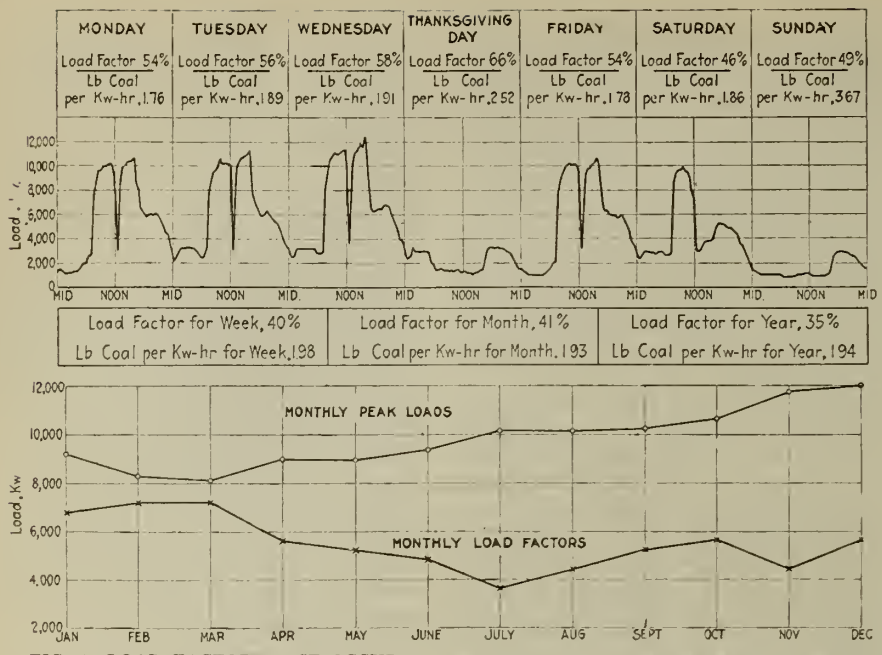


FIG. 4—LOAD FACTOR AS IT OCCURS FROM DAY TO DAY AND MONTH TO MONTH.

TABLE I.
OPERATING EXPENSES AS AFFECTED BY LOAD FACTOR.

	Operating Expenses, Cents per kw-hr.		
Annual load factor, per cent.	30	50	70
Fuel	$0.91	$0.85	$0.71
Labor for operation	0.10	0.07	0.06
Miscellaneous do.	0.04	0.03	0.03
Maintenance, mater. and labor	0.08	0.05	0.04
Total	$1.13	$1.00	$0.84

It is interesting to note, however, that the load factor for the year is practically the same in these two cases. This is due to the effect of the extremely low loads which obtain on Sundays and holidays. For these two conditions, illustrated by Fig. 3, having practically the same annual load factors, the better annual coal rate would be obtained with the one having the more favorable shape of load curve, that is, with the one in which the factory load predominates.

Fig. 4 shows how the load and load factor vary from day to day and month to month for a business in which factory load predominates. The beneficial effect of high load factor on Thanksgiving Day, for example, is much more than offset by the relatively small load on the station on that day. Note how the load factors for the week and for the month are practically the same. The load factor for the year is somewhat lower due to the variation in maximum demand throughout the various seasons. In general the better coal rates are obtained with the higher load factors, although this is greatly influenced by peak load, quality of fuel, and skill in operation, all of which are interesting subjects but beyond the scope of this discussion.

Discussion

In the extended discussion at the power session of the annual meeting, those whose remarks dealt more particularly with Mr. Junkersfeld's paper were Messrs. Charles Penrose and James T. Enes. Mr. Penrose stated that it is perhaps the foremost duty of the engineer to act as conserver of the natural resources and to obtain the greatest possible economy in power-station design. If this is true, he said, then instead of designing a power plant for existing loads it should be designed for abnormally high loads and then the load should be developed. This could be secured by a combination of circumstances and loads, including railroad electrification, street railway load and industrial uses. There has been secured, he said, within a short radius from New York City a load factor which at the present time, exclusive of Saturday, Sunday and holidays, has the high figure of 78 per cent.

Mr. Enes referred to the relation between the investment and load factor, which in turn depends upon fixed charges and operating expenses. Since we are now entering a new era of increasing prices, he said, it will be very difficult and perhaps impossible to determine such charges. We have in mind prices and the actual value based on the entire life of the plant. The problem is thus complicated because of the fact that we are now entering upon a period of increasing prices.

PALM OIL AS A FUEL

The world's supply of mineral oil is limited. At least, so say geologists, so that the experiments with vegetable oil as a motor fuel should be of decided interest. The oil used in these experiments has been palm oil, well known in the commercial markets as one of the most desirable ingredients of the nut-margarines. The tests have been carried on in Brussels, with a view of making use of palm oil, if practicable, as a motor fuel in the Kongo. The difficulty of transporting mineral oil to the Kongo, and its high cost when delivered —about $1.40 per gallon—made the finding of a substitute a great desideratum. And, as palm oil was one of the products of the Kongo, and could be had there for about 20 cents a gallon, the reward for its successful adaptation was alluring.

The calorific value of palm oil varies from 75 to 80 per cent. of that of mineral oil; therefore, from one-fourth to one-third more must be burned to get the same power.

The experiments have proved that palm oil will work perfectly in a certain form of motor of a semi-Diesel type without any change, in the ordinary Kongo temperatures. In Belgium, however, where the winter temperatures are below the solidifying point of palm oil, an accessory is necessary to liquefy the oil. Further, in Belgian winter temperatures it has been advisable to start the motor with petroleum, and when it is well warmed up to substitute the palm oil.

The experiments have shown that palm oil burns completely, leaving no residue. So far the trials have been made chiefly on motor boats, but they are being extended to tractors and industrial motors. In July, 1920, the Belgian Ministry of Colonies initiated a prize contest for tractors operated on any of the vegetable oils produced in the Kongo. Only one contestant appeared—an evidence of the lack of research along this line.

With the passing of petroleum, an eventuality already being discounted by the geologists, the practically unlimited production of vegetable motor oils may easily become one of the important industries of the near future.

VICKERS-PETTERS CATALOGUE

We have received from Messrs. Vickers, Petters, of Ipswich Works, Ipswich, England, their very well-illustrated catalogue, describing their semi-Diesel stationary and marine engines. These engines are made in sizes from 10 H.P. to 450 H.P. and they are designed to run on a great variety of fuel oils, and are equipped with a special starting device which enables them to start up from cold in a minute. A special arrangement of fuel injunction is used when the engine is running light, which enables it to run for long periods on no load or light load without misfiring. The catalogue describes the engines in great detail, and with plenty of illustrations. There is a page of the booklet devoted to hints to overseas buyers which should be carefully perused by any intending purchasers in this country. The name of the firm is of course sufficient guarantee of the workmanship put into these engines.

Jardine and Company, Canadian representatives for the American Manganese Bronze Company, have removed from their old offices at 285 Beaver Hall Hill into more commodious quarters at 180 St. James St., Room 102.

Explosion In High Pressure Air Line*

Explosion Ruptured Steel Pipe That Had Test Pressure of 2,500 lbs. Per Square Inch. Pipe Was Supplying Air to Compressed Air Locomotives at About 1,000 lbs. Per Square Inch

By E. D. GARDNER, Mining Engineer

AN explosion occurred in a high-pressure compressed-air line in October, 1920, at an Arizona copper mine. The explosion was unusual, and nothing had been noted by the plant operators to indicate the possibility of such an occurrence. The mining company uses compressed-air locomotives to haul about 4,500 tons of ore per day from the stopes to the pockets at two hoisting shafts. The ore cars hold five tons each, and are pulled in trains of 20 cars. It is necessary to charge the locomotive with compressed air at both ends of the trip. The air is conveyed from the compressors at the surface to the distributing points underground in special high-pressure four-inch steel pipe that was tested to withstand 2,500 pounds per square inch before being installed. The air is delivered to the locomotives at a pressure of 1,000 pounds per square inch. There are no receivers in the system.

The air for running the locomotives is compressed by one three-stage and two four-stage compressors which have capacities of 600 and 300 cubic feet per minute, respectively. These machines are operated by electric power, and are in an end of the main compressor building in which air is compressed to supply the air drills in the mine. Whenever the demand decreases, as at the noon hour, one or more of the compressors are shut down. On this particular occasion, at the end of the noon hour, one of the operators was approaching the high-pressure compressors to start the two smaller machines that were not running, when the explosion took place under the floor a few feet ahead of him. The man was knocked down and received some superficial cuts and bruises, but was not seriously injured. The floor was torn up, the side of the building blown out and holes knocked in the roof some twenty feet above. The explosion was immediately followed by a fire which was quickly put out by the plant operators with hand fire extinguishers.

At the time of the explosion the 600 cubic foot compressor was running alone, and the pressure in the system at the machine registered 1,040 pounds per square inch. On examination it was found that two 8-foot sections of pipe, about ten feet apart, were completely ruptured into twisted fragments; the rest of the pipe line apparently was not injured. The destroyed sections were in that part of the pipe near the large compressor and above the connection from the two smaller machines. It is not definitely known what caused the explosion. Explosions in other compressed-air systems have taken place, and, although of rare occurrence, have caused loss of life. Such explosions are not confined to high-pressure installations, and several have occurred at plants compressing air to one hundred pounds per square inch, or less. Explosions of this nature are not to be confused with the rupturing of compressor cylinders from excessive air pressure caused by discharge valve being closed.

A number of theories have been advanced to account for explosions in air lines, but there is not enough evidence to state positively that any one condition is responsible, and it is possible that there are a number of contributory causes. To obtain a gas explosion, two conditions are necessary; first, an explosive mixture, and, second, something to set it off. Enough oil must be fed into the cylinders of an air compressor to lubricate properly the moving parts, and in order to insure this an excess is used which may accumulate somewhere in the system. When oil is fed into the cylinder it is partly vaporized by mechanical action of the air. The quality of the oil used has an important bearing on the operation of the compressor, and is probably the most fruitful cause of explosions in receivers or air lines.

Apparently all cylinder oils are carbonized to some extent in the compressor cylinder, and, if the poorer grades of cylinder oil or those not adapted for the purpose are used, large deposits of carbon may accumulate in the air lines or receivers. This carbon is inflammable, becomes oil soaked, and is always a source of danger. Heated air from the compressor may cause the carbon to burn and thus vaporize the deposited oil in sufficient amount, together with any coming from the compressor, to form with the compressed air an explosive mixture. This mixture may then be exploded by the hot air, or, more likely, by a glowing point of carbon.

The temperature of the air in air compressors increases with the ratio of compression. The temperature at the end of the piston stroke in a single-stage machine, compressing to 100 pounds per square inch, is 425° F. above the intake air. In a 100-pound two-stage compressor with no intercooling, the increase of the air temperature is 180° for each cylinder. The final temperature of the air at the discharge end of the last cylinder of a three-stage machine compressing air to 1,000 pounds per sqaure inch, would be about 1,280°, if the air enters the compressor at 60° and no heat is lost by radiation.

The flash point of a series of paraffin-base compressor oils listed in a pamphlet issued by the Ingersoll-Rand Company varies from 375 to 500°, and the firing point from 425 to 575°. The flash point of a series of compressor oils with asphalt base varies from 305 to 375°, and the firing point from 360 to 404°. It will be noted there is only a small margin between the temperatures generated in the cylinders and the flash and the firing point from 360 to 404°. oils. Under high pressure the flash point would be lowered. Even if the oil vapor would not explode at the firing point, as held by some writers, an oil accumulation may start to burn which in itself might supply sufficient heat to cause an explosion. It seems likely, also, that an explosion in air lines could be brought about by the compressors being out of adjustment and the heat in the compressed air building up to a dangerous point.

Leaky valves in compressors are dangerous, and are held by some compressor men as generally being responsible for over-heating the air. In some types of compressors the discharge valve in the last-stage cylinder may not be tight, due to carbon deposits or some other cause, and a small part of the heated air may be drawn back into the cylinder with each stroke and be re-compressed. There is a difference of opinion, however, as to whether a leaky discharge valve can result in excessive over-heating of the compressed air. Theoretically, the air leaking back would cool to the temperature it was in the cylinder before being compressed, but it appears that, due to the churning motion of the piston and other heated moving parts, the temperature may rise sufficiently to vaporize the oil and cause an explosion.

Ordinarily the heat is effectively absorbed in high-pressure installations by a water intercooling system, but any stoppage or restriction of the water-flow would allow the temperature of the air in the compressor to increase rapidly to a dangerous point. In some types of compressors it is possible for the temperatures to build up when the air is not being used, by excessive unloading of the machine if a small leak occurs in the throttle unloading valve. With the compressor running and the valve closed, the intake side of the cylinder is in a vacuum. A small leak in the valve would permit some air to enter

*Railway and Locomotive Engineering

the cylinder, but it would be below atmospheric pressure. As the increase of temperature in the air varies with the ratio of compression, excessive heating is possible in this case. For example, under the above conditions, by assuming that the pressure in the intake side is 5 pounds per square inch and the compressor is furnishing air at 105-pound pressure, the ratio of compression would be twenty-one to one against seven to one under normal conditions. Most modern compressors, however, are equipped in such a manner that any air compressed under the above conditions is discharged to the outside atmosphere with no ill effects.

An inefficient oil trap may contribute to the explosion by permitting an unusually large amount of oil to leave the compressor with the air. Oil may burn in the pipe line and cause no damage, or a small explosion may take place with not sufficient force to rupture the pipe line, and carbon monoxide may be generated in the line. It is reported that men have lost their lives from carbon monoxide coming through the compressed-air line to the working face of a drift. To prevent explosions in air lines, the first consideration is to use the proper grade of cylinder oil, and, second, the compressor valves and intercooling system should be kept in good order. An aftercooler would appear desirable in high-pressure installations. Care should be taken that only fresh air be drawn through the intake of the air compressor.

COMBUSTION DEVELOPMENTS IN ENGLAND

Hard thinking arising out of the lessons of the war has brought about some unusually interesting developments in engineering abroad, according to Geo. E. Learnard, the president of the Combustion Engineering Corporation, who is at present in Europe in connection with the business of the newly formed International Combustion Engineering Corporation. He has sent the following interesting comments and observations on conditions in the combustion field in Europe.

"Although, when I left the United States, I felt that through our correspondence and affiliated companies I was well advised of the progress in European countries in the field of combustion engineering which field encompasses a more efficient utilization of raw fuel and labor saving devices wherever steam is made or fuel is burned, I am nevertheless surprised by what I have seen.

"I think engineers in the United States little appreciate the hard thinking on this side arising out of the lessons of the war.

"That countries such as England and France having no deposits of oil and, in the case of England, insignificant water power, should be devoting close attention to the extraction of oil from coal and to the employment of semi-coke for steam raising and for furnaces, was to be expected when we remember that one of the chief lessons of the war was that a country without oil is in a dangerous position.

"Another lesson arising out of the war, namely, the necessity of labor-saving devices to compensate for the reduced man power of the European countries has seemingly been taken to heart, and I have seen here certain devices toward labor saving in boiler rooms beyond anything known to me in the United States. Even under the present conditions of ample labor supply, due to slackness in general trade, these devices are being pressed into use, for commercialism is obliged to yield to the growing pressure of public sentiment as well as labor unions, toward the elimination of man-breaking and manual labor.

"As to the abstraction of oil from fuel, there is a considerable agitation in the country toward legislation making it compulsory that certain fuels should not be burned in their raw state, and that the light oils and certain tars should be extracted before they are used for furnace work or for steam raising. It is safe to forecast that in another ten years no highly bituminous coals in England will be burned in their raw state.

"The means placed at my disposal for investigating several new processes have convinced me of the rapid strides being made toward practical success in this field, but, unfortunately, since my information has been obtained in confidence, I am only permitted to mention one or two of these processes, or methods, in general terms.

"While oil from bituminous coals is being extracted in England by one large company in considerable quantities, and on a commercial basis, by processes akin to well-known American methods, the future, in my opinion, lies in two new inventions which are being experimented with and perfected in secret.

"One of these treats the fuel by internal heating in such a little space, and with such simplicity of mechanism, that the oil is extracted and the fuel reduced to semi-coke while it is progressing, steadily, by gravity from the main bunkers containing the raw fuel to the mechanical stoker hoppers. These mechanical stokers are specially adapted for receiving and burning the hot semi-coke from the interposed retort or distilling apparatus between the stoker hoppers and the main bunkers.

"The advantages of such a compact self-contained simple apparatus need not be seen to be appreciated. I am not permitted to elaborate or describe the detail of the apparatus more fully.

"The second method which I have investigated is of prime interest to those who are believers in the ultimate general employment of pulverized fuel for steam raising and furnace work.

"In this, the distillation of the fuel takes place while the fuel is being reduced to a powder, i.e., while it is being pulverized.

"Instead of this method for obtaining light oils and certain tars adding to the complication of pulverized fuel equipment, it appears, on the contrary, to simplify it, since the drier used in the ordinary pulverized fuel system disappears, and also since the powdered fuel, being in the form of semi-coke, enables it to be transported with a simplification of machinery or apparatus. Furthermore, this semi-coke is of such a character that it may be stored indefinitely without being affected by moisture or heat. The gases from the fuel in process of distillation are in part condensed to oil in the usual way, and the remainder carried to the furnace burners and injected into the furnace with the powdered semi-coke.

"Returning to the question of labor-saving devices in boiler rooms of the several called to my attention, decidedly the most interesting is an automatic ash conveyor for use in power stations, or wherever watertube steam boilers or metallurgical furnaces are employed.

"It was my pleasure to examine one of these conveyors at work, and I was indeed startled and astonished by its perfection of operation."

HAS FAITH IN THE ELECTRIC ROADS

Railway Engineer Quotes Figures That Show Where Savings Would Be Made

London.—The superior financial and operating advantages, together with the coal problem, will eventually compel the electrification of all Canadian railways, D. M. Morrison, chief engineer of the London & Port Stanley Railway, told the Rotary Club. Mr. Morrison declared that the electric locomotive is capable of working 24 hours a day seven days a week; that an electric railway can haul a third more freight than a steam road on this continent, and that maintenance of way charges are 50 per cent. less when electric locomotives are used. He stated that if all the steam roads in the United States were electrified the saving in coal annually would amount to 122,500,000 tons.

Trade Gossip

The briquette plant at Bienfait, Sask., which is subsidized by the Manitoba, Saskatchewan and Federal Governments, will begin manufacturing briquettes early in May, it was announced. The buildings are completed and only a little additional machinery remains to be installed. Several tests will be made before the briquettes are placed on the market. The plant was built at a cost of $500,000.

The H. Mueller Mfg. Co., Ltd., Sarnia, Ont., are contemplating the erection of an iron foundry.

A Course of Instruction for the Graded Certificate

The Various Types of Valves and Gears Met With in Stationary Practice—A Short Description of These Leading Up to the Method of Making the Adjustments Necessary for Good Results

By T. H. FENNER

IN the most recent articles we have explained fairly exhaustively the use of the indicator card, although, of course, there are further uses which we have not yet gone into. However, we believe that this is as far as will be necessary for the purposes of a course of this kind, but if readers express a wish for any particular question to be treated more fully, we will be glad to take it up.

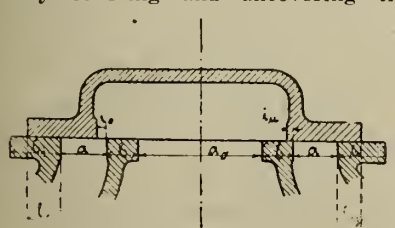
It is now in order to take up the more practical side of the steam distribution, in other words the setting of the valves, slide or otherwise, in order to get the best results. Before going into the actual valve setting, we will describe some of the types of valves in general use.

Types of Slide Valves

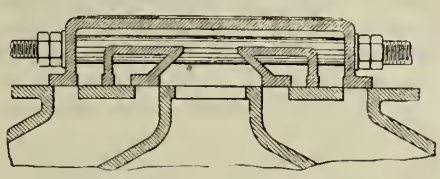
There is, of course, first of all the basic type or the common slide valve, in its original form without inside or outside lap, and in its later and more generally used construction, with both inside and outside lap. From this a number of modifications have been brought into being, such as the double ported slide valve, the triple ported slide valve, and the piston valve. There is the slide valve with the Meyer expansion valve fitted to the back, and the slide valve with a relief ring. All these forms have been introduced for the purpose of getting a large port opening with a small valve, thus reducing friction and weight of moving parts. The piston valve was introduced to get away from the heavy pressure on the back of the slide valve in high pressure engines, and is really a balanced valve. Piston valves are adopted largely in high-speed engines, and in the high-pressure cylinders of compound marine engines.

The Common Slide

The ordinary slide valve consists essentially of a casting with two flat edges and a raised centre. This raised centre forms an arch or cavity into which the exhaust steam is discharged from the cylinder, and communicates with a passage leading to the exhaust pipe. The flat edges perform the steam distribution by covering and uncovering the steam port, which is, of course, both inlet and outlet port alternately. Every engineer is familiar with this type of valve. It is simple, easily understood and widely used, but has its limitations. One of these is that the period of cut off cannot be made much less than half stroke without seriously interfering with the other function, as we explained in previous lectures, and another is that



THE D SLIDE VALVE



THE DOUBLE PORTED VALVE.

when the engine gets into the larger sizes, the slide valve tends to become unwieldy, and a cause of large friction losses. Thus it becomes necessary to adopt some modification to overcome these defects.

The Double Ported Valve

The double ported slide valve is a valve which has passages formed in it leading to the valve face, so that the steam, besides entering the port over the outside edge of the valve, can also enter through the back of the valve. The exhaust cavity remains the same as in the ordinary valve, but both ports can be put in communication with the exhaust cavity at once. The construction of the valve can be clearly followed from the illustration. The valve shown is in midposition, and therefore closed to both steam and exhaust. It will be seen that steam enters the port through the chamber from the back of the valve, and the inside bar acts in exactly the same way as the outside one. It is evident that with the same travel of valve practically double the port opening can be obtained that is possible with a single ported slide valve. These valves are sometimes made triple ported, but this is not so usual. The same factors govern the steam distribution as in the single ported valve, the only difference being in the increased port opening and quicker cut off. This does not mean earlier cut off, but a shorter length of time occupied in covering the port than would be the case with a single ported valve. This is easy to understand when we consider that the valve has only to move half the distance that a single ported valve would to either open or close the port. The shortened travel also decreases the friction, and for the same port opening a lighter valve can be made. This construction with a relief ring on the back of the valve makes a good working arrangement.

The Trick Valve

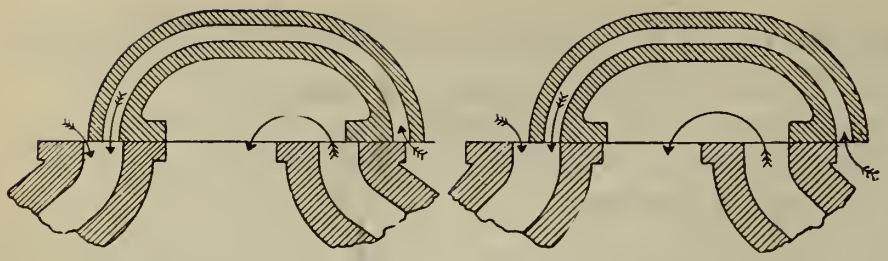
Another type of valve which was once largely used on locomotives is known as the trick valve. In this valve a passage is cored out from one side of the valve to the other. The valve is so arranged that when the valve is in mid position the passage just covers the valve chest face. When the valve opens to steam at one end, the passage at the other end overlaps the valve chest face, thus admitting steam from that end through the passage to the steam port, the effect being the same as achieved with the double ported valve. The passage has no effect on exhaust, which takes place over the inside edge of the valve in the usual manner.

The Piston Valve

The piston valve is a form of slide valve, and may be conceived to be a slide valve which is bent round to the form of a circle. If a piston valve is developed, that is laid out in flat form, it will be seen to comprise two flat edges with a cavity in the centre just like a common D slide valve. It has, however, one great advantage over the slide, and that is on account of its construction it can be made self balancing by admitting the steam in the centre, and exhausting over the ends, instead of admitting steam over the ends and exhausting through the centre. When steam is admitted in the centre, the pressure acts on the inside of the two pistons, thus placing the valve in a state of equilibrium, and the effort necessary to move it is only that due to the friction, and not to the weight. The friction is much reduced owing to the steam having no effect in pressing the pistons against the wall of the chest. Another advantage is that the glands have only low pressure steam to contend with instead of the boiler pressure, and in the case of a simple engine, the pressure on the stuffing box packing is only atmospheric. The piston valve is used largely in high-speed engines, both horizontal and vertical, and almost exclusively on the high-pressure cylinders of compound marine engines. The trick construction is occasionally used in piston valves, but not very frequently.

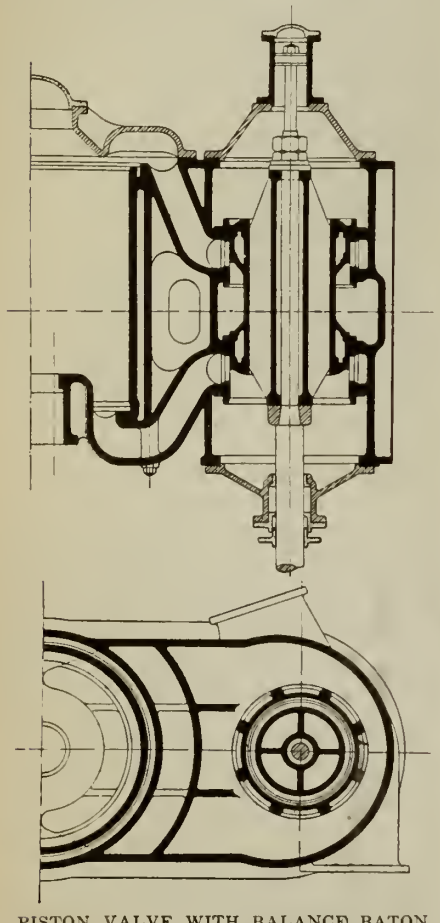
Quick Cut Off Valves

The necessity of getting a quicker opening to steam and a quicker cut off at an earlier point led to the introduc-



THE TRICK VALVE

tion of different forms of valves and gear. The principal of these is the Corliss, of the semi-rotary type. The Brown is a species of the poppett valve, while valves of the Wheelock and Macintosh Seymour type are really slide valves of the multi-ported variety, with special gear to get the quick opening and closing features. The effect of all these types of valves on the indicator card is



PISTON VALVE WITH BALANCE BATON

to give much sharper corners at the changing of the straight lines into curves, thus eliminating wire drawing of the steam at cut off, and a quicker drop of pressure at release. This tends to a greater area or card with the same steam supply. The Corliss valve is operated by an eccentric through suitable gearing, as is also the Wheelock and the Macintosh Seymour, while the Brown and poppett valves are operated by cams mounted on a cam shaft driven by gearing from the main crank shaft, like a gas engine.

The Corliss Valve

The Corliss valve is a semi-circular valve, its shape in cross section being of a T form. It is not connected solidly to the valve spindle, but is driven by a T head on the spindle which fits in a slot in the valve end. On the spindle there is keyed a bell crank, known as the steam arm, and one end of this is furnished with a die which engages with a hook, this hook being operated from the wrist plate by means of a connecting link. The other end of the steam arm lever is connected to the dash pot rod, which pulls the steam arm back rapidly after the hook disengages with the die on the other end of the arm. The point of disengagement is decided by the position of a loose cam also mounted on the valve spindle, and operated by a rod from the governor. Cut off can be set at any point from about one-eighth stroke up to half stroke by means of the governor rod. There are four valves on each cylinder, two steam and two exhaust. In many engines the exhaust valves are driven by a separate eccentric, thus making adjustment of the steam valves entirely independent of the exhaust. In other arrangements all four valves are driven by one eccentric, which operates a wrist plate to which all four reach rods or links are connected. The diagram illustrates quite clearly the construction.

The Wheelock Valve

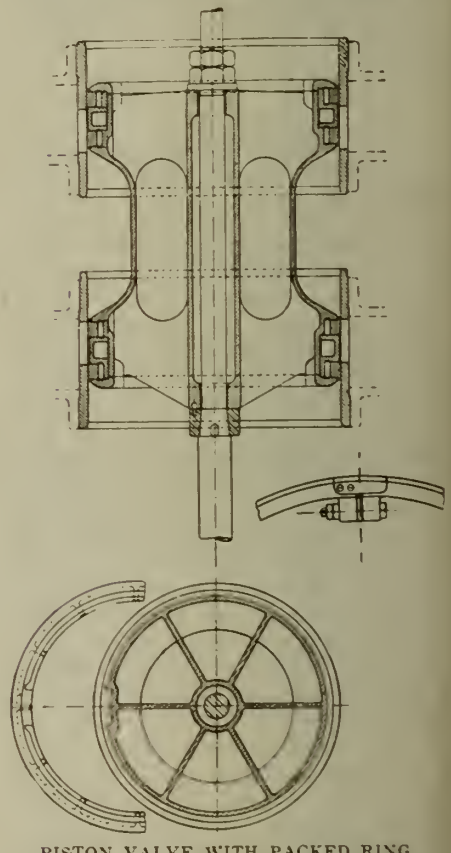
This valve is of the gridiron type, or multi-ported slide valve. The valve is operated by a knuckle joint, which is driven by rods attached to a link and wrist plate. Dashpots are used to give the quick cut off feature, and the governor determines the point of cut off in a similar manner to the Corliss gear. A feature of this valve is that both valve and seat are carried on a taper plug casting, which can be removed bodily from the cylinder for repair when necessary.

The Macintosh Seymour Valve

The arrangement built by this firm is somewhat different to any of those just described. The four-valve feature is adhered to, but in addition to this there is a riding cut off valve on the back of the main steam valves. The main eccentric operates the main steam and exhaust valves while the cut off valves are operated by an eccentric which is driven by the flywheel governor. There are no dashpots in connection with this gear, but the effect of the various links which connect the valves to the eccentrics gives the quick opening and closing required. These engines can be adjusted within very fine limits, and practically any kind of card that the operator wishes to get can be obtained by a little manipulation.

The Meyer Expansion Valve

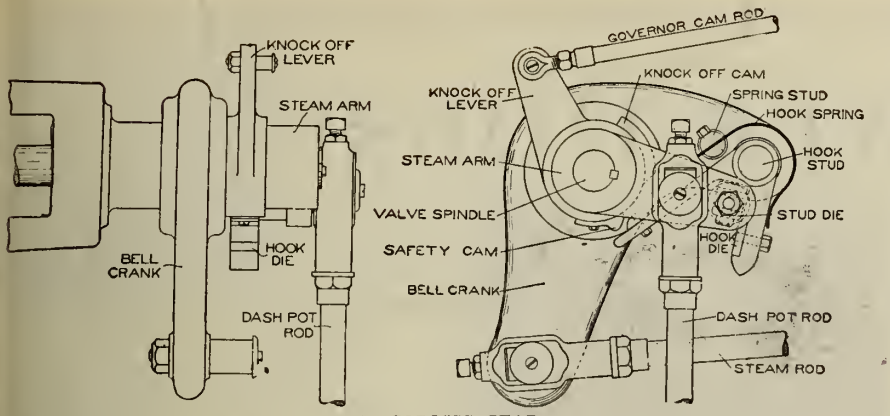
The Meyer expansion valve is a means adopted to get an early cut off with the ordinary slide valve, and consists of two flat plates made to work on the back of the main slide valve. The ports on the main valve are cut right through the valve, and the expansion valve governs the admission of steam to the ports of the main valve. The two plates can be drawn closer together or moved further apart by means of a right and left hand screw which passes through both plates and the distance these plates are apart determines the period of cut off. These valves will be found largely on steam cylinders of pumping engines, air



PISTON VALVE WITH PACKED RING

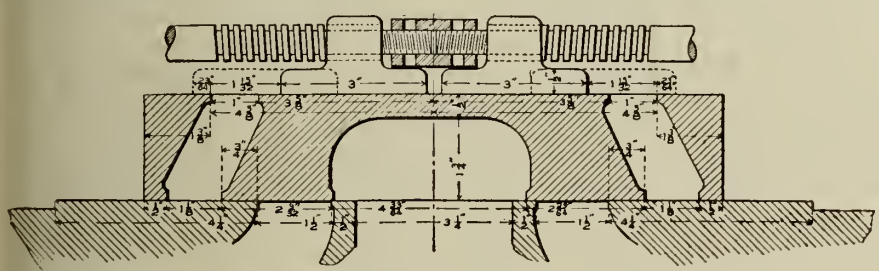
compressors, etc., and have the advantage of giving speedy adjustment from light load to a heavier one. They have the effect of adding to the friction, and need another eccentric to drive them. The eccentric to drive the expansion or cut off valves is set 90 degrees in advance of the main eccentric.

The foregoing covers the most generally used valves in the stationary field, and we can now give some thought to the setting of the various types. There is generally speaking not much difference in the methods employed to



THE CORLISS GEAR.

t any kind of valve, and furthermore ere is nothing excessively difficult out the operation. The motive power practically all the valves in general e is the eccentric, and if this is cor-ctly placed the fundamental require-ent in valve setting has been achieved.



THE MEYER VALVE.

he further adjustments are small and asily determined, both in the ordinary ide valve and the drop cut off valves. he first job therefore is to determine ie correct position for the eccentric ith reference to the crank, and to do iat we must be able to place the engine n the dead centre at either end with recision and certainty.

POWDERED COAL.

A paper that is considered to be of special value and timeliness was read ecently before the Providence Engineer-ig Society on the "Development in owdered Coal Burning" by H. D. Sav-ge, a member of A.S.M.E., A.I.M. & I.E., who is recognized to be an author-y on this subject.

Mr. Savage based much of his discus-ion on Rhode Island graphitic anthra-ite coal, using it as an instance of nferior fuel that was being made of arge commercial value through the pul-erizing process. The author of the aper is one of the experts of the ombustion Engineering Corporation on his subject, and is credited with having uch to do with making the advantages f pulverized coal known to the engin-ering world.

After a brief review of some of the istory of pulverized fuel, Mr. Savage in his paper takes up the Rhode Island deposit in showing where pulverization solves a difficult question.

The paper says in part:

"In the coal reserves of the United States the supply of Rhode Island graphitic anthracite is estimated at about 1,000,000,000 tons. Think of the enormous economic possibilities presented by the development of this deposit as a substitute for the very costly imported product—an accomplishment by no means imposisble of achievement.

"The Geological Survey, however, has not in the past taken a very optimistic view of this possibility. To quote from Professional Paper 190-A:

" 'The Rhode Island anthracite region, although known since 1760, is of little economic importance, for the coal has never been mined for a long period on a commercial scale, and, judging from its composition and the metamorphism of the surrounding rocks, it seems doubtful whether it will ever have more than a local value, if it is worked at all.'

"Assuming, however, that modern methods of mining have made the recovery of this coal possible on a commercial basis, there would seem to be no further obstacle to its use as an industrial fuel of merit.

"The inferiority of Rhode Island graphitic anthracite as compared with Pennsylvania anthracite when burned by the ordinary methods is due to its physical structure and the nature of the ash content. The only difficulty met in burning this graphitic coal in ordinary methods is that the ash will not free itself as combustion progresses. The coal makes a very brilliant fire for a short space of time, but the lump soon becomes surrounded with ash and is snuffed out. When burned in suspension in pulverized form combustion is, of course, instantaneous, and this trouble does not exist. The elimination of this one difficulty, therefore, makes it a thoroughly reliable and usable fuel. This assertion is based on very meagre information, to be sure, as the only test which we ran on this coal covered a period of only four hours and some four tons of coal. This test, however, clearly indicates that in a correctly designed plant there would be no difficulties encountered when burning this fuel in pulverized form. Figures covering the short test run are given herewith, as is also an analysis of the coal. There was no attempt made to run a boiler test, but simply to establish for our own satisfaction the fact that this fuel was of value, and that it could be burned under proper conditions.

"The low efficiency might be accounted for by the fact that this test was run in the early days of our development, and on an installation which was purely experimental, and which has since been abandoned for a more efficient type of furnace construction. However, since this test we have been prepared to make an installation under definite guarantees, but there seems to be but little interest in the development of this native product, which appears to us to have vast possibilities.

"The best results in burning anthracite of any kind are obtained when a constant rating can be maintained, as a high temperature in the surrounding refractories is a factor in securing desired results. It will not be found a satisfactory fuel for low ratings, or where the boilers are banked any considerable length of time, except in special cases, where the plant is designed for that particular service."

PROPERTIES OF METALS

An investigation into the properties of white metals for bearings has recently been carried out by the Bureau of Standards. It was found that tin-base alloys maintain their strength properties better at elevated temperatures than do those containing lead. However, the yield point or ultimate strength of a high-grade babbitt at either 25 deg. or 75 deg. Cent. is not affected by lead admixtures up to 3 per cent. Prolonged heating lowers the strength of lead-base alloys much more seriously than it does that of tin-base alloys. The yield point of a tin-base alloy was not affected by heating for six weeks at about 100 deg. Cent., but the yield point of a lead-base alloy was lowered by only two weeks' heating at the same temperature.

Member of the Audit Bureau of Circulation

POWER HOUSE

APRIL 5th, 1921

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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Doing a Good Work

IT is the custom of a good number of firms engaged in the manufacture of power plant apparatus and accessories to have lantern slides prepared illustrating the installation and use of their product. These slides are made available to engineering societies or technical schools for educational purposes, and serve the very useful purpose of enabling the engineer to acquire a knowledge of the different equipment that is available. This is good for the firm and instructive to the engineer, and it is also of benefit to the plant owner. The more engineers that can be made familiar with the principles and methods of operation of different kinds of equipment, the better for the men themselves and the men that employ them. The firms which manufacture the apparatus have the benefit of knowing that their equipment will get a fairer show if installed in the plant of an engineer who has already been made familiar with it through the medium of illustrated lectures. Makers of engineering specialties know only too well that their installations have often proved unsatisfactory not through any fault of their own, but from lack of interest and sometimes pure ignorance of the men who are responsible for their functioning.

The work being done by these firms is a good one for all concerned, and we hope more and more of them will take this means of acquainting the stationary engineer with the merits of their products. This is altogether apart from any advertising value the slides may have, for we believe that these slides are lent by the firms who own them without any other idea than to help out the engineers who are so often their clients. If they do gain some little advertising value, no one would be churlish enough to object. The larger good they are doing justifies them.

The Higher Standard

THE chairman of the Board of Examiners for Ontario, speaking at the annual banquet of the Toronto Lodge, C.A.S.E., spoke of the hopes and aims of the Board in raising the standard of stationary engineer in Ontario. Mr. Brown alluded to the Board of Trade certificate, and pointed out that it was a guarantee practically all over the world, and he wished to eventually raise the standard of the Ontario certificate until it too would be the best evidence a man could have of his ability. This cannot be done all at once, and at the beginning allowance has to be made in many cases, but the examinations will be gradually stiffened up as the engines in general get better educated technically and more fit to pass stiff theoretical examinations.

We believe with Mr. Brown that the standard of the examinations should be gradually increased until it is a real test of a man's ability both theoretically and from the point of view of experience. That is the function of an examination, but it does not, as some people imagine, stamp every one that passes it with the hall mark of standardization. We mean to say that you can take half a dozen men and set them down at the same examination board. They may all pass, and pass with equal marks, but that does not make them all equally capable in their work. They may each have the same amount of technical knowledge, and each have the necessary amount of experience to help out that knowledge, but one of the six will be a much more valuable man than any of the others, and there will be varying degrees between them all.

The fact remains however, that each one has passed a test which shows that he has a certain minimum amount of fundamental knowledge of his business, and a certain length of time has been spent at it. The higher the standard of the test, the less chance there is of the weak men passing . who may bring the whole thing into disrepute.

A Square Deal

IN another page of this magazine we publish a proposed form of contract to govern the purchase of coal as between buyer and seller. The form has been drawn up by the National Association of Purchasing Agents, an association that includes Canadian representation. There has long been a need of a standardized form that would protect the purchaser from the inconveniences and delays due to alleged car shortages, and real car shortages, inferior quality of coal, and all the other annoyances which the coal purchaser has had to put up with in the past. The form includes a statement of the approximate analysis of the coal contracted for, thus affording a definite standard for the quality of coal delivered. Weights are to be governed by the actual railway weights at the point of shipment from the mines. We do not notice any provision to protect the purchaser against loss by the way, which is sometimes considerable, depending on the kind of car the shipment is made in. On the whole, the form seems to be a fair deal to both parties, and there is, of course, nothing to prevent special clauses to govern special cases being put in. Very close limits as to description and analysis can be exacted by the purchaser, and should be used to protect his interests.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

BORING AIR CYLINDER

Question.—Will you please answer the llowing question: In what condition ould an air cylinder be left in, after boring, smooth or rough, and give asons?

Answer.—Generally speaking, if the linder liner or wall is of a good gray ose-grained iron, that is a hard iron, should be finished as smooth as is posble, because with a metal of that kind e wear will take place on the piston ngs sooner than on the cylinder wall. is the practice in some cases to leave e cylinder slightly rough, and allow e piston rings to wear the tool marks t of the liner. The rings are made ersize, so that when the cylinder is orn smooth they will be large enough be tight. As a rule, the metal of the linder should be harder than that of e rings, as it is a much easier matter fit new rings than to rebore a cylinr. Leaving a cylinder rough after rning is apt to score the rings during e wearing down process, and we should ways recommend the cylinder being nished smooth, and the rings made a od fit to start with.

MOUNT OF CIRCULATING WATER

Question.—A condenser on a steam engine is 6 feet long and fitted with 600 bes 6 feet long and ⅝ inch outside iameter. We wish to use the lake water r circulating purpose and would like to now how many gallons of water it will ke to keep 25 inches of vacuum?

Answer.—If you wish to maintain 25 ches vacuum that means that the temerature of the hot-well water will be bout 120 degrees. The engine is given s 250 horsepower and in the absence of ny figures we can assume that the team consumption is about 20 pounds er i.h.p. per hour. That would be ,000 pounds steam per hour. The total eat of that steam would be at 25 inches acuum 1,115 B.t.u. and the latent heat ,021 B.t.u. We can assume that the tent heat alone is given up to the conensing water, the temperature of the ondensate being that of the hot-well. Ve have then 1,021 x 5,000 pounds or ,105,000 B.t.u. per hour to be given up the circulating water. If the temerature of the circulating water is aised from an initial temperature of ay 60 degrees to 110 degrees, that is 0 B.t.u. per pound condensing water, we have 5,105,000 divided by 50, which is 102,100 pounds water per hour or 10,210 gallons. Of course, if the initial temperature is lower the quantity required is less. The amount given agrees closely with figures of recognized authorities, who give with circulating water at 60 degrees and vacuum at 26 inches from 17.5 to 21.9 pounds water per pound of steam condensed. In this case we have 5,000 pounds steam per hour condensed and 103,100 pounds water, which is 20.4 pounds water per pound of steam.

DUPLEX PUMPS

Question.—What makes a duplex pump short stroke on one side? Water not hot enough to form a vacuum. When cylinder cover is taken off water end, water still remains in chamber.

Answer.—The usual cause of a duplex pump short stroking one side is a leaky suction valve, though, of course, it may be due to the valve gear not being properly set. In the ordinary duplex pump, when the valve arms are hanging vertically from the bracket, the valves should be just covering the ports, or in other words, in mid position. We do not understand the latter part of the question in the form it is given. Please make this clearer.

BOILER HEATING CAPACITY

Question.—Kindly inform me how many cubic feet one boiler horse power will heat?

Answer.—I presume you mean the quantity of cubic feet of air, by your enquiry as to quantity of cubic feet one boiler horse power will heat.

One boiler horse power is the evaporation of 34.5 lbs. water per hour from and at 212 degrees F. This is $34.5 \times 966 = 33{,}327$ B.T.U. 1 cubic foot air heated from 0 to 70 requires 1.25 B.T.U. Then you could heat 26,661 C.F. air per hour from 0 to 70, or a room about 65x20x20.

One cubic foot water contains 62.5 lbs., and to heat it from 32 degrees to 162 degrees would require $62.5 \times 70 = 43{,}752$ B.T.U. Therefore, 1 B.H.P. would heat 7.6 lbs. water 70 deg. per hour.

Boiler horse power is like indicated horse power, a rate of doing work, and it would be better to say that so many cubic feet of air could be heated so many degrees by so many B.T.U. regardless of time.—Editor.

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Progress in New Equipment

A NEW HIGH PRESSURE DAMPER REGULATOR.

A new hydraulically operated damper regulator, suitable for boiler pressure up to 250 pounds, has recently been developed by the Atlas Valve Company, 282 South Street, Newark, New Jersey. It is designed to automatically regulate the steam pressure on high pressure power boilers.

The cross-sectional view of this regulator shows all details. The operating water, under pressure, enters the regulator through the inlet A and, as indicated by the arrows, passes to the pilot valve, then to the bottom of the control cylinder through port D. It also passes to the control cylinder on top of the piston through pipe E into the hollow piston stem and into the control cylinder through holes F.

The pilot valve stem I is of spool form with the upper head passing over port D, which when above the port permits the water to pass into the bottom of the cylinder, and when below the port permits the water to escape from the bottom of the cylinder into outlet C.

The area of the top of this piston is reduced by an amount equal to the cross-sectional area of the piston stem, whereas the area of the bottom of the piston is larger. We therefore have two opposing forces pushing against opposite sides of the piston, the constant pressure acting against the lesser area on top of the piston tending to force it down, and the variable pressure from the pilot valve tending to push it up. Therefore, when pressure is admitted to the bottom of the cylinder the piston is forced up, and when the pressure is permitted to escape from the bottom of the cylinder, the constant pressure forces it down.

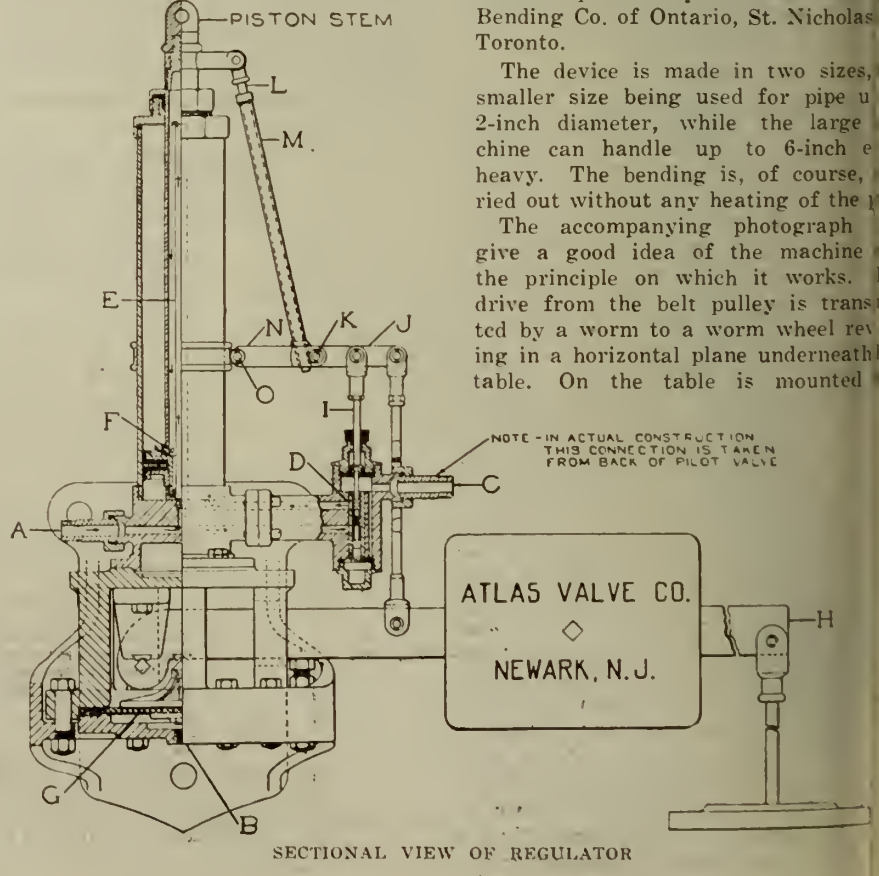
The Compensating Attachment.

When the steam pressure under diaphragm G is sufficient to raise lever H, the pilot valve stem I is pulled up by lever J, swinging on axis K; this permits the water to pass into the bottom of the control cylinder and force the piston up.

As the piston moves up rod L is pulled upward in sleeve M, which is rigidly attached to lever N, swinging on axis O. As the point where rod L is attached to the piston stem travels in a straight line, the angle at which sleeve M stands is lengthened, and to meet this longer angle sleeve M must swing outward, which depresses axis K on the end of lever N. This pushes pilot valve stem I down, so that the upper head of the stem covers port D, and shuts off the water supply to the bottom of the control cylinder, which checks the upward travel of the piston.

When the steam pressure falls, lever H lowers and pulls pilot valve stem I down, so that its upper head is below port D. This permits the water in the bottom of the control cylinder to escape into outlet C, which allows the constant pressure on top of the piston to force the piston down.

As the piston moves down rod L, sliding into sleeve M, shortens the angle at which sleeve M stands, and to meet this shortened angle sleeve M must swing inward, which raises axis K, and pulls pilot valve stem I up so that the upper head of the stem covers port D, and shuts off the water discharge from the bottom of the cylinder, which checks the downward travel of the piston.



SECTIONAL VIEW OF REGULATOR

The importance of the compensating attachment cannot be overestimated as it acts as an intermediary medium to counteract the movement transmitted to the pilot valve by the steam pressure under the diaphragm, which balances the position of the damper on intermediate pressure changes, and permits the damper to be fully opened or closed only on extreme boiler pressure variations.

This regulator will be known as "Victor No. 3." Victor No. 1 is made for low pressure heating boilers; Victor No. 2 is for medium pressure power boilers.

AN INTERESTING PIPE-BENDING MACHINE

The problem of bending wrought iron pipes to various degrees and getting the bend without distortion of the pipe has always been an interesting one. Many devices have been introduced to achieve the desired result, and we recently had the opportunity to see one of these at work. The machine in question is manufactured and operated by the Tube and Pipe Bending Co. of Ontario, St. Nicholas St., Toronto.

The device is made in two sizes, the smaller size being used for pipe up to 2-inch diameter, while the larger machine can handle up to 6-inch extra heavy. The bending is, of course, carried out without any heating of the pipe.

The accompanying photograph will give a good idea of the machine and the principle on which it works. The drive from the belt pulley is transmitted by a worm to a worm wheel revolving in a horizontal plane underneath the table. On the table is mounted

BENDING AUTOMOBILE EXHAUST PIPES.

form for bending, and these forms are, of course, made to accommodate the various sizes to be bent. The pipe to be bent is placed in the jaws of the vise and is run through between the form and vise the necessary distance to form the bend. The mandrel carried on the table is then run into the pipe just as far as is necessary. A series of stops on a quadrant under the table can be set to any number of degrees that may be required. When the pipe is set, the operator presses a pedal, which thows the head carrying the mandril into gear with the revolving worm, thus turning the head and mandril, and, of course, the pipe, through the arc previously settled. When the stop is reached, the machine disengages automatically. The mandril, owing to the path described by the table, automatically draws out of the pipe as the bend is formed.

The machine can be used to put several bends in a pipe, and we saw a number of exhaust pipes for automobiles which contained no less than five bends. One great feature with a machine of this kind is that, once it is set, it can produce any number of absolutely identical bends. This makes it especially useful where large numbers of pipes must be bent to a uniform standard. We had an opportunity to examine some four-inch pipe which had been bent to about 60 degrees, and there was no sign of any wrinkles or distortion on the inner side of the bend. A large number of bends on extra heavy pipe for marine work were performed on the large machine during the shipbuilding activities recently, and were all passed by Lloyd's surveyors.

We understand this machine is fully protected by patents in Canada and the U. S.

A COMPACT POWER PUMP.

A very neatly arranged power pump is being manufactured by the Thomas Machine Shop, 339 King Street W., Toronto. The pump, as shown in the accompanying illustration, is mounted on a bedplate which carries all the necessary gear for driving. The driving pulley is keyed to the first pinion shaft, and the pinion is cut from the solid cold rolled shafting, thus eliminating any chance of worn keys or keyways. The spur gear is keyed directly on to the crank shaft, and is a heavy cast iron gear 6 pitch. The gear also forms one side of the disc crank, and the connecting rod bearing is of heavy bronze, working on the pin between the discs. The rod itself, as can be seen from the cut, is of extra heavy construction. The pump itself is made entirely of bronze, as is the piston and pump rod. A notable feature of the pump is the fact that the valves are all outside, and consist of four standard design check valves of the swing type. This not only ensures a long life for the valves, but makes the repairing of a valve a matter of minutes only.

The arrangement is very convenient for all purposes where small pumps are needed, and especially where the nature of the fluid to be pumped is corrosive. The pumps are made up to 4 x 4 inch. The piston and piston rod glands are packed with the usual hydraulic packing.

NEW POWER PUMP

PUMP GOVERNOR BULLETIN.

Having acquired sole rights to manufacture and sell Ideal pump governors, the Atlas Valve Company, 282 South Street, Newark, N. J., are now distributing their first bulletin describing this excellent governor—Bulletin No. 1—A, Edition No. 1.

The bulletin is unusual in that it is complete. It shows photographs of finished pump governors, shows cross-sectional drawings with all parts numbered, installation and operation are fully explained, it gives dimensions, and it also contains prices. The purchaser can therefore order directly from the bulletin without preliminary correspondence.

It includes descriptions of the Ideal pump governor for turbine or reciprocating steam driven pumps; for marine or stationary turbines; fire pumps, lubricating oil pumps, bilge pumps, fuel oil pumps, a pump governor equipped with an emergency control lever for saturated or superheated steam, and automatic shut-off pump governor which automatically shuts down a pump in case of accident to the pump discharge line; a relief valve for oil pumps accepted by the United States Navy for use on Navy vessels suitable for light or heavy oil under high or low pressure; and a high pressure hydraulic regulating valve suitable for pressures from 500 to 1,000 pounds per square inch. The Ideal pump Governor is approved by the National Board of Supervising Inspectors of Steam Vessels, and it is also approved by the Bureau of Engineering, United States Navy Department. Two pages of the bulletins are devoted to special type of Ideal governors for accumulators, for high pressure fire hydrant service to reduce the main pressure to a safe carrying hose pressure, for hydraulic pumping rams, and for pumps for low pressure salt or fresh water, acids, oil, ammonia, gas or air-line service.

A copy of the bulletin will be mailed to any reader of this publication upon request.

THE LARGEST COOLING TOWER

It is claimed that the cooling tower erected by the Dodge Brothers at their Detroit plant is the largest in the world. It is 146 feet long, 42 feet wide and 104 feet high. It is capable of cooling 18,000 gallons of water per minute from a temperature of 105 degrees to 85 degrees when the outside temperature is 72 degrees and the relative humidity is 69 per cent. With other atmospheric conditions the water will be cooled to within 25 degrees of the existing dew point with a minimum temperature of 45 degrees. The loss of water by evaporation under these conditions amounts to 5 per cent. The tower has been strongly built and is braced to be able to withstand a wind of 90 miles per hour.

The Operators' Point of View

THE PERPETUAL AIR COMPRESSOR.

The scheme that Mr. Nicholaides has devised from his air compressor undoubtedly looks well on paper. The fault being that it is based on a false premise, naturally, the conclusion is also false. It is not a question of how much energy was expended to produce a certain amount of compression, but of how much energy this compression will furnish when again expanded. Because a single air compressor (such as the one he describes) requires 172,800 foot pounds of energy to produce one cubic foot of air at 150 pounds pressure, it does not follow that he should lay claim to perpetual motion, because his arrangement will produce a cubic foot of air at 150 pounds pressure with a smaller expenditure of energy. It merely goes to show the inefficiency of the single air compressor. Quoting from Mr. Nicholaides' article, he says: "Suppose that we use back those eight cubic feet of air, compressed as we stated to ten atmospheres, viz.: as a driving force in another set, we will not obtain back the whole amount of the 172,800 pounds, as some power is lost on account of friction, produced heat, and other causes." Very good! Had he taken the trouble to figure out the amount of power he could get back from his one cubic foot of air, he would never have made any such claim as 200% efficiency. As he did not do it, let us do it for him. As he admits a loss of 30% in the last or eighth cylinder, we will not bother with that one, but simply use it as a reservoir holding one cubic foot of air at 120 lbs. pressure. Now, if we expand this down to atmospheric pressure we shall find out exactly how much work it will perform. Let us take this eight cylinder engine and, starting with one cubic foot of air at 120 lbs. pressure, allow it to expand back into cylinder number seven. Thus we increase the volume to two cubic feet and decrease the pressure to sixty lbs. This will give us an M.E.P. of 90 lbs. 90 x 144 gives us 12,960 foot lbs. of work performed in cylinder number seven. As it required 16,980 foot pounds of work to compress this cylinder full of air, we already have a loss of 4,320 foot pounds in the first stage of its expansion. Now let us try expanding it again. Allow the air to back up into cylinder number six. As the air is now three times the volume it will be one-third of the pressure at the end of the stroke. This gives us 40 lbs. and with an initial pressure in this cylinder of 60 lbs. gives us an M.E.P. of 50 lbs. 50 x 144 is 7,200, and this is the energy in foot pounds which we may obtain from this cylinder. The energy required ofr this cylinder was 8,640 foot pounds, so here we have a loss of 1,440 foot pounds, or one-fifth of the initial pressure required. To continue, expand this air down to its final expansion, and it gives us respectively these M.E.P.'s: 35 lbs. in the fifth, 19.5 in the fourth, 7 in the fifth, 3.6 in the sixth, and 1.1 in the last. The sum total is as follows: 1st expansion, M.E.P. 90 lbs., work performed, 12,960; 2nd expansion, M.E.P. 50 lbs., work performed, 7,200; 3rd expansion, M.E.P. 35 lbs., work performed 5,040; 4th expansion, M.E.P. 19.5 lbs., work performed, 2,808: 5th expansion, M.E.P. 7 lbs., work performed 1,008; 6th expansion, M.E.P. 3.6 lbs., work performed, 518; 7th expansion, M.E.P. 1.1 lbs., work performed, 158; the total work performed in foot pounds is 29,692, and as we did not do any work in the eighth cylinder, by subtracting the steam required for that cylinder from the total amount required to run the compressors (that is 59,918—21,600 equals 38,318) we can arrive at the figures necessary to find the thermal efficiency of the whole arrangement.

Thus we have: total energy required to compress eight cubic feet of air into one cubic foot — 38,318 foot pounds. Total energy obtained from one cubic foot of air, expanded to atmospheric pressure—29,692. Now, divide 29,692 by 38,318 and we get an efficiency of .77 approximately. This I think is sufficient refutation of the perpetual motion theory. There is no doubt that this arrangement of cylinders would give a much higher thermal efficiency than the single air compressor, but how it would compare with one of the larger compressors, which compound both the air and the steam, is a matter for others to take up. Suffice it to say, the mechanical difficulties in the way of constructing such an apparatus are almost insurmountable. To point out a few, I would ask: "How could the steam be regulated for pressure and timing?" "How would the air be cooled from one cylinder to another without having undue clearance space?" Then again, "How would initial cost and upkeep compare with a single stage compressor?"

What Mr. Nicholaides is trying to do is, apparently, to secure the hyperbolic compression of air by a hyperbolic utilization of steam power in a series of cylinders. Whether it can be done or not depends on experimentation. If it can be done, it will, undoubtedly, give a higher efficiency than the single stage compressor, but it would not give the efficiency that a gear-driven compressor will give. In conclusion I should like to say that I have used the figures on the diagram in all my calculations, so that even if these are wrong in the first place it will make no difference to the ultimate result. It stands to reason, that when air is compressed, a certain amount of work is performed, also there is a certain loss from friction steam condensation, heat generated by compression which can never be recovered in any way, but it takes more energy to perform this work than can ever be recovered from it again. One thing which we should thank Mr. Nicholaides for is for bringing so clearly to our notice the thermal efficiency of the single stage compressor and it is quite probable that through the instrumentality of his idea a much more efficient method of compression may be evolved. His idea is excellent and I wish him luck with it, though he will, most certainly, never get his compressor to run itself by the power it generates.

Reg. A. Woods,
Saskatchewan Provincial Hospital.
Battleford, Sask.

* * *

To Editor, Power House:

It appears to me that a revision of the figures on the sketch shown on page 30 of the March 5, 1921, "Power House" shows that the inventor of the device would be sadly disappointed in the performance of a pair of working models (if such were constructed and operated in comparison); the one model having a single steam cylinder as per the upper left hand corner of the sketch; the other having eight steam-driven cylinders as per the lower portion of the said sketch.

In making the computations one might use any one of a number of sets of formulae, but for convenience let us choose a simple one. Simple formulae, not the most precise, but sufficiently accurate for our purpose become—after exchanging some of the letters for others which I think will serve the present case

etter—

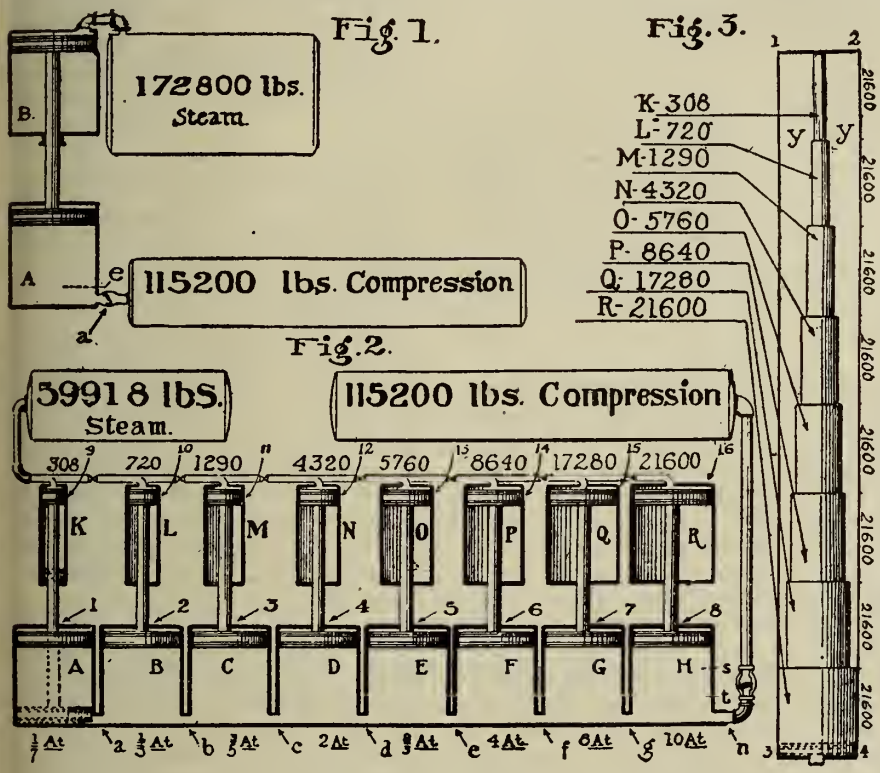
$A = \frac{M}{R}$; also $A = \frac{L}{R} - 1$; $R = \frac{L}{A+1}$;

$I = L - R$; $\frac{L}{R} = A + 1$; $\frac{L}{R} - 1 = A$.

When A = atmospheres pressure by he gauge.

A + 1 = atmospheres pressure (absolute).

L = total length of space between the iston and the farther end of the cylin-



ler when the piston is at one extreme nd of the stroke.

M = the distance the piston has moved orward.

R = the distance remaining between he piston and that end of the cylinder oward which the piston has been approaching.

For fair play the main thing is to, whatever set of formulae is used, use he same formulae and methods for each lass of device being compared. Also or convenience we will use decimals in omputing the atmospheres of pressure. We will also assume that in each case onstant temperature is maintained and hat there is no "clearance" nor leakage o be accounted for.

In the eight air cylinder machine and with—

Piston No. 1 down we have $\frac{M}{R} =$

1 ÷ 7 = .142 atmospheres pressure by he gauge.

Piston No. 2 down we have $\frac{M}{R} =$

2 ÷ 6 = .333 atmospheres pressure by the gauge.

Piston No. 3 down we have $\frac{M}{R} =$

3 ÷ 5 = .600 atmospheres pressure by the gauge.

Piston No. 4 down we have $\frac{M}{R} =$

4 ÷ 4 = 1 atmospheres pressure by the gauge.

Piston No. 5 down we have $\frac{M}{R} =$

5 ÷ 3 = 1.666 atmospheres pressure by the gauge.

Piston No. 6 down we have $\frac{M}{R} =$

6 ÷ 2 = 3 atmospheres pressure by the gauge.

Piston No. 7 down we have $\frac{M}{R} =$

7 ÷ 1 = 7 atmospheres pressure by the gauge.

Piston No. 8 down we have $\frac{M}{R} =$

10 atmospheres pressure before full stroke.

Total, 23.741, which multiplied either by 144 and by 15; or by their product, which is 2,160, we have 51,280.560.

The respective terminal pressures on the pistons are—

	(Calculated)	(Approx.) (gauge)
On No. 1	(206.72)	207 lbs.
2	(719.28)	720 "
3	(1,296.)	1,296 "
4	(2,160.)	2,160 "
5	(3,598.56)	3,600 "
6	(6,480.)	6,480 "
7	(15,120.)	15,120 "
8	(21,600.)	21,600 "
Totals	51,280.56	51,283 "

The difference in the totals being due to the difference between "calculated" and "approx." pressures given for pistons 1, 2 and 5. The total for the "calculated" column agrees with the total previously secured—51,280.56. As the strokes are each one foot long these would be foot pounds of energy exerted except for the fact that these figures are for terminal pressure instead of for mean pressure, which would be less.

It will be noticed that these calculations do not agree with the figures on the sketch since there the first three pistons and the last one are calculated to atmospheres by gauge, while the 4th, 5th, 6th and 7th are calculated to atmospheres absolute. Subtracting one atmosphere or 2,160 from the figures given in the sketch, for each of the four pistons last mentioned, brings them into accord with the figures given above.

For testing the formulae given above let us start with all the pistons up. We know then that L and R each equal 8 and that M and A each equal O; then the formula $A = \frac{M}{R}$ becomes $O = \frac{O}{8}$ and the others become respectively $O = \frac{8}{8} - 1$; $8 = \frac{8}{O+1}$; $O = 8 - 8$; $\frac{8}{8} = 8$; $A + 1$ (thus $A = O$) $\frac{8}{8} - 1 = O$.

With the first six pistons down we know that L = 8; M = 6; R = 2; and A is given above as 3.

Then $3 = \frac{6}{2}$; also $3 = \frac{8}{2} - 1$; $2 = \frac{8}{3+1}$; $6 = 8 - 2$; $\frac{8}{2} = 3 + 1$. $\frac{8}{2} - 1 = 3$. The same may be tried on each piston except No. 8, but with it the valve into the reservoir is supposed to open at a pressure of ten atmospheres gauge, thus preventing further accumulation of pressure. Hence our formulae do not fully apply then.

Now for the upper left hand corner of the sketch. It is there assumed that 144 × 15 × 8 × 10 = 172,800 foot pounds of steam power are required to compress 8 cubic feet of air to 10 atmospheres pressure, and this regardless of the fact that when the attached air piston starts at atmospheric pressure and that when it has reached mid-stroke the pressure against it is only 15 pounds per square inch or 2,160 altogether. To obtain a fair comparison with the other device we must calculate the piston pressures on this at eight points also, say at positions 1½ inches apart. Then at the beginning of the stroke the pressure is one atmosphere absolute or no pressure by the gauge. At a position 1½ inches

$$\text{therefrom } \frac{M}{R} = \frac{1\frac{1}{2}}{10\frac{1}{2}} = .142 \text{ at. gau.}$$

$$\text{At 3 inches } \frac{M}{R} = \frac{3}{9} = .333 \text{ at. gau.}$$

$$\text{At } 4\frac{1}{2} \text{ inches } \frac{M}{R} = \frac{4\frac{1}{2}}{7\frac{1}{2}} = .600 \text{ at. gau.}$$

$$\text{At 6 inches } \frac{M}{R} = \frac{6}{6} = 1.000 \text{ at. gau.}$$

$$\text{At } 7\frac{1}{2} \text{ inches } \frac{M}{R} = \frac{7\frac{1}{2}}{4\frac{1}{2}} = 1.666 \text{ at. gau.}$$

$$\text{At 9 inches } \frac{M}{R} = \frac{9}{3} = 3 \text{ at. gau.}$$

$$\text{At } 10\frac{1}{2} \text{ inches } \frac{M}{R} = \frac{10\frac{1}{2}}{1\frac{1}{2}} = 7 \text{ at. gau.}$$

At 12 inches it is discharging at 10 at. gau.

The total is 23.741 atmospheres and when multiplied by 144 and by 15, or by their product, which is 2,160, it becomes 51,280.56, just as was the case with the eight-cylinder air machine. The loss of power is mentioned as 30 per cent. At that rate the 51,280 becomes 35,896 and the figures are 51,280 and 35,896 instead of 172,800 and 115,200 as given in the sketch. If the compressed air were used again for power purposes the loss might be more nearly 50 per cent. than 30 unless uncommonly, I might almost say exceptionally, efficient machines were used.

In the above there appears to be an error due to calculating the 1½-inch sections of the 12-inch stroke at the same foot pounds value as though the sections were one foot long; but, since eight working strokes are required for compressing the stipulated eight cubic feet of air, and since $1\frac{1}{2} \times 8 = 12$, the figures given are obviously the same as though we had calculated each section at its true terminal value in foot pounds and then multiplied by the number of working strokes. Again, in the eight air cylinder machine we did not make sections for each cylinder nor piston pressure. This is because each of the eight cylinders constituted the parallel or equivalent of one section (during the eight working strokes) of the single air piston machine. We could make sixteen or more calculations for each machine but would be no nearer proving a gain of efficiency of one machine over the other. The adoption of stage air compressors is evidence that multi-cylinder machines, to a certain extent at any rate, may prove more efficient in practice than single cylinder machines; but they cannot attain 100 per cent. efficiency.

The main oversight in the sketch is, I believe, the assuming that the steam in the steam cylinder of the single air cylinder machine is working against a pressure of ten atmospheres during its entire stroke. The next is in assuming that the air compressed by the 308 pounds work on piston No. 1 of the eight air cylinder machine is compressed to ten atmospheres in the last cylinder without any further expenditure of work. In reality that air exerts a resistance against each of the remaining seven pistons and they in turn each expend a portion of work on it before it reaches the final pressure of ten atmospheres in the last cylinder.

Too often the man who invents something aside from the line of his own occupation, or for some purpose, the existing devices for which are not well understood by him, loses money.

J. McCormack.

* * *

Editor, Power House:

Cylinder A contains 1 cubic foot air at atmospheric pressure (14.72 at sea level, 30″ barometer), to compress that volume air to 10 atmospheres (or 132.3 pounds gauge pressure) and allowing 30 per cent. loss for heat, friction and other causes, we need a total pressure on steam

$$\text{piston of } \frac{132.3 \times 144 \times 130}{100} = 24{,}767$$

pounds, but we will only need this pressure at end of stroke and for 8 cubic feet $24{,}767 \times 8 = 198{,}136$ pounds. Now, the pressure in compressor cylinder is zero (or 14.7 absolute) at beginning of stroke and 132.3 at end of stroke, and it would only take enough steam to overcome friction to start piston on its travel. During the early stage of the stroke the steam piston has a slowly accumulating load to carry, while later on this load is multiplied very rapidly. Now in figuring out foot-pounds for an air compressor we cannot take the pressure at end of stroke, multiply it by travel and call it foot-pounds, which is what Mr. Nicholaides has done in his compressor No. 1, while in his compressor No. 2 he has figured his work (foot-pounds) in eight stages. The same could have been done in his first compressor, by taking one-eighth of the stroke at a time. Now he is wrong to start, which, of course, gets worse as he goes along.

Now allowing 100 per cent. mechanical efficiency (not possible) and isothermal compression, we would have a mean effective pressure in air cylinder of $\frac{132.3}{2} = 66.15$ pounds or in foot-pounds with 30 per cent. loss per cubic foot $= \frac{66.15 \times 144 \times 130}{100} = 12{,}383$ foot-pounds and for 8 cubic feet $12{,}383 \times 8 = 99{,}064$ foot-pounds.

An indicator curve for an air compressor, comprising 10 atmospheres, would (isothermal curve) be pretty near straight from 14.7 pounds (absolute pressure) to 147 (absolute) while the indicator curve for steam cylinder would be nearly constant as power at beginning of stroke would be stored in flywheel and helping to carry piston over the latter part of stroke. The writer has had occasion to take readings of a electric motor, belt connected to an a compressor, and only very slight varia tion was visible on the ammeter.

I do not see any need in going furthe with his calculation and then our learne friend from San Diego must have fo gotten Boyle's law when he says, "Th law cannot apply in stage compression I learned the law as: "The absolute pre sure of a gas varies inversely as i volume, at constant temperature." Th latter part he must have forgotten.

I sincerely hope this explains it. not, I have our editor's little note i last issue of the Power House as a excuse. My certificate of competenc as a stationary engineer is only thi class.

Ernest Quist.

UNIFORM COAL CONTRACT

For some time past the Fuel Commi tee of the National Association of Pu chasing Agents has been engaged i formulating recommendations for rea sonably uniform provisions in coal co tracts. The purpose of the committe has been to express its idea of a fa contract to be used for the purchase an sale of coal. To avoid overlooking im portant details and to prevent any bia in its suggestions, the committee co ferred with a number of leading pr ducers and wholesalers in the coal field holding a meeting for this purpose a the Hotel Pennsylvania, New York, o March 15.

The conclusions of the committee ar expressed in the form of contract at tached. It is believed that the form ca be advantageously used for most com mercial contracts for the purchase o coal, and where special conditions re quire special clauses these might be ado ed to the contract.

The form has been prepared simply a a convenience to the members of th National Association of Purchasin Agents and the trade, and is submitte by the committee for the use of thos whose requirements it will meet. It ha been carefully worked out to cover al general conditions and is particularl designed to prevent misunderstanding between buyer and seller such as aros from the loosely drawn agreements i effect last year.

The administrative council of the Fue Committee of the National Associatio of Purchasing Agents is as follows Chairman, E. H. Hawkins, of E. I. d Pont de Nemours & Co., Wilmington Del.; H. M. Mitchell, of Rome Mfg. Co Rome, N.Y.; J. E. Stuaffer, of A. M Byers Co., Pittsburgh, Pa.; R. M. Sedg wick, of Standard Chemical Co., To ronto, Ont.; H. M. Cosgrove, of J. H Markham, Jr., Tulsa, Okla.; H. L. Ogden of Gas & Electric Improvement Co. Boston, Mass.

In the preparation of the propose contract form the committee has had th guidance and advice of W. B. Symmes Jr., of New York, formerly solicitor fo the United States Fuel Administration

(This is contract form for coal recommended by the National Association of Purchasing Agents)

Agreement entered into this .... day of..... 19...., between.....

of ....., hereinafter referred to as Seller,

and ..... of .....
hereinafter referred to as Buyer.

The Seller hereby agrees to sell and deliver and the Buyer hereby agrees to purchase, between the ..... day of .....,

19.... and the ..... day of ..... 19....., the quantity and kind of coal and at the price hereinafter stated upon the terms and conditions herein contained, to wit:

QUANTITY ..... net tons

RATE OF SHIPMENT (approximately) ..... net tons per month

DESCRIPTION

Approximate Analysis

PRICE $..... per net ton of 2,000 lbs. f. o. b. cars mines.

POINT OF DELIVERY: f.o.b. cars mines.

TO BE SHIPPED TO .....

DESTINATION .....

ROUTING .....

KIND OF CARS PREFERRED .....

TERMS AND CONDITIONS

1. Invoices shall be paid on or before the ..... day of each month for all coal shipped during the preceding calendar month. Non-compliance with said terms of payment shall give the Seller the right to suspend further shipments until all previous shipments are paid for, and if in the judgment of the Seller the financial responsibility of the Buyer shall at any time become impaired and written notice thereof be given by the Seller to the Buyer, the Seller shall have the right to suspend further shipments until adequate security for payment hereunder is furnished by the Buyer. If such security is not furnished within thirty days from such notice, the Seller shall have the right to cancel this agreement.

2. All settlements shall be governed by the actual railroad weights ascertained at the usual points at which railroad shipments from the mine or mines producing the coal shipped hereunder are weighed.

3. Strikes, fires or accidents at the mine or mines where the coal sold hereunder is produced, embargoes, shortage of car supply or other similar occurrences beyond the control of the operator of such mine or mines which prevent or interrupt the shipment of such coal, shall excuse Seller's failure to ship hereunder during the continuance of such occurrence, **provided**,

(a) the Seller is the owner or exclusive sales agent of the mine or mines at which the coal sold hereunder is produced, or prior to or simultaneously with the execution of this agreement has entered into a written contract for the purchase of a sufficient quantity of coal from such mine or mines to fulfill the obligations of the Seller under this agreement;

(b) the name of the owners and location of such mine or mines is stated in this agreement;

(c) the Seller gives the Buyer written notice within five days after such occurrence of the exact nature, extent and probable duration thereof with sufficient detail to enable the Buyer to verify the same;

(d) the total available tonnage of said mine or mines during prevention or interruption of shipments as aforesaid is applied pro rata on all contracts then in force or any renewals thereof for the output of such mine or mines exclusive of contracts or sales made after such occurrence;

(e) Shortage of car supply shall not excuse failure to ship hereunder if at the time of such failure there are in force contracts for the sale of more than the rated output of such mine or mines based on the car rating given such mine or mines at the date of this agreement by the railroads on which the same are located.

4. In case of strikes, fires, accidents or causes beyond the control of the Buyer which wholly or partially stop the works of the Buyer, shipments contracted for shall be suspended or partially suspended as the case may require upon written or telegraphic notice to the Seller.

5. If the Seller shall fail to ship or the Buyer shall fail to accept the monthly shipments herein provided for and shall be excused for such failure under Articles "3" and "4" hereof, the other party at any time after the expiration of the first three months of the contract period may, by written notice to the party who has so failed to ship or accept, reduce the monthly tonnage thereafter to be shipped and accepted hereunder to an amount equal to the average of the monthly shipments for the three months preceding such notice.

6. The purchase of the coal specified herein is based upon present agreements with mine employees as to wages, and any increase or decrease in the cost of production of the coal shipped hereunder caused by changes in such wage agreements or by the imposition by State or Federal Statute of a direct tax on coal or the mining thereof or subsequent changes in the rate of such tax shall correspondingly increase or decrease said price of coal on any tonnage thereafter shipped hereunder and affected thereby.

7. The coal covered by this contract is to be used only in the plant or plants of the Buyer and is not to be sold or diverted by the Buyer to other purposes without the consent of the Seller.

8. Waiver by either party of any default by the other hereunder shall not be deemed a waiver by such party of any default by the other which may thereafter occur.

9. Notice sent by telegram or registered mail, addressed to the party to whom such notice is given, at the address of such party stated in this agreement, shall be deemed sufficient written notice in any case arising under this agreement.

10. No understandings, agreements or trade customs not expressly stated herein shall be binding on the parties in the interpretation or fulfillment hereof unless such understandings, agreements, or trade customs are reduced to writing and signed by the respective parties

In witness whereof, the parties hereto have caused this agreement to be executed in duplicate by their respective officers duly authorized the day and year first above written.

..... Seller..... Buyer

By .....By .....

SOME GOOD ADVICE

By James Scotch

Numerous inquiries are made from time to time by correspondents in the columns of the technical press about steam engine trouble. Many of the letters sent to the press are so lacking in data that any "absent treatment" remedy suggested by readers must necessarily be only a guess at what the ailment is.

When a pound or knock suddenly develops in an engine some men seem to lose their engineering acumen, and in a sort of panic, try this, that, or the other thing, apparently hoping that if they try a lot of things they may be lucky enough to hit on the right one.

Often the right remedy is used and the pound removed. It is a fact that quite often the man who performed the operation is not aware of which change did the business because he had tried several at once, instead of testing one at a time.

Sometimes when a bad pound develops the engineer will try out a few remedies that he knows about, or has heard of. When he fails to get results he develops a feeling of helplessness, and writes to his favorite journal. Before he does this he should carefully study and consider the conditions and peculiarities of the pound, mentioning them in his letter. He should state what remedies he has tried out without success. As a rule any knock suddenly developing in an engine is of a simple nature, easy to cure if it can be located. It is sometimes mighty difficult to locate, and engineers even with a lifetime of experience may spend considerable time looking for the trouble. Engines are somewhat like humans in many ways. I once had charge of an engine which ran along month after month with little or no attention outside of oiling and cleaning. Suddenly it started to pound and search as we would it could not be placed. It was an old slide valve affair, slow in speed and heavy in build, one of the old timers which while none too economical in steam consumption, usually ran for 20 years or more without a cent for repairs outside of packing. It was so reliable that it was almost impossible to believe it could fail. I coaxed and petted it, examined bearings, bolts, nuts, etc., and everything seemed O.K., but just as soon as it was started the pounding returned. Ultimately a slight side slap was located at the eccentric. The knuckle joint on the eccentric rod had become a little worn and although there was only about 1-32 of an inch play, it was enough to cause the pound. Possibly and probably the knuckle joint had been loose for months, so why did not the pound start sooner? I imagine the engine got angry because the joint was not attended to. Regrinding and tightening the joint removed the pound.

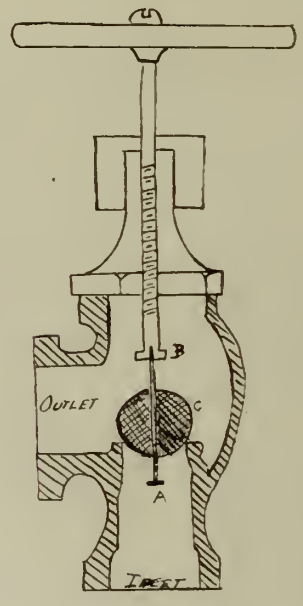
Another time a nasty pound started in an "Ideal" high speed engine direct connected to a D.C. generator. After considerable testing a small bolt or set screw on the flywheel governor pin was found to be loose. Nothing else was wrong.

Another time such a set screw loosened up but no pound started. What did happen was that the operation of the generator was affected, because the engine governor was not working properly.

My object in writing this is to impress on the minds of men not used to writing for the press to get the proper data as near as possible before asking mail order treatment for engine trouble.

A USE FOR OLD VALVES.

Hundreds of angle and globe valves are discarded as junk when they would supply months of useful service on cold water on gas mains. The accompanying sketch shows a method by which this can be done. This valve takes the place or answers the purpose of a check as well as a stop. A hard rubber ball, C, is used instead of the disc, the disc and holder are removed from the stem, and



VALVE FITTED WITH RUBBER.

a hole drilled and threaded at B to take the rod A. A hole is made through the ball just big enough to allow the ball to move on the rod freely. When the valve is closed the stern end at B makes a tight joint. When the valve is open, the stop at A holds the ball up. To act as a check valve, the stem is placed in the position shown. One defect as a check valve is that it will not be absolutely tight, as a certain leakage will escape through the rod hole. However, there are many temporary jobs where this made-over valve would answer nearly as well as a new one.

A WORD FROM QUEBEC

Editor Power House:

I am the holder of a second-class certificate in the Province of Ontario and also in the Province of Quebec. I have often felt like going back to Ontario, thinking stationary engineering would b much better since the graded certificat came into force. After reading an ac vertisement in the Montreal Star fc March 31st, I have come to the conclusio that I am better off in the Province c Quebec. The ad is as follows: Wanted- Fireman holding second-class certificat Apply Canadian General Electric Cc Peterborough, Ont."

I hope the chief engineer of the Can dian General Electric found a secon class man to handle the scoop. I wond how he would like to have seen the sar ad a few years ago when he carried second-class certificate. I consider th an insult to any man holding a secon class certificate. Is it possible that the are so many second-class engineers Ontario that they have to go back firing, a job they have presumab climbed from years ago?—W. P. R Montreal.

ANNOUNCEMENT.

Louis T. Klauder has resigned fro the Philadelphia Rapid Transit Compar as construction engineer and will ent the consulting engineering field. He a graduate of the Williamson Scho and of the Drexel Institute in mechan cal and electrical engineering.

Mr. Klauder entered the enginee ing department of the Pennsylvan Iron Works Company in 1901. He b came associated with the Philadelph Rapid Transit Company in 1905, wi which company he has occupied in tu positions of draftsman, chief draftsma assistant engineer and construction e gineer, in charge of plant design a construction. In his consulting work l will specialize in that field of enginee ing in which he has been most acti and progressive.

Like many of the more successful e gineers, he has kept in close contact wi the advances of his profession throu membership in major engineering soci ties with which his activities are associa ed, being a member of the Americ Society of Mechanical Engineers, Ame can Institute of Electrical Engineers, a the Engineers' Club of Philadelphia.

Through the organization of an offi as unusual as it is distinctive, Mr. Kla der is already directing a number municipal industrial power plant develo ments, among which are the new wat and lighting plants of the city of Jam town, New York.

On and after April 1st, 1921, Mr. E. Jones will be in charge of the N York office of the Homestead Val Manufacturing Co., at No. 242 Lafayet street, New York City, where he w carry a large and complete stock "Homestead" Quarter-turn Valves a "Hovalco" Valves, and be in readine to give prompt service to all custome in this district.

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The absolute dependability of Fairbanks-Morse Motors accounts for their extensive use in Power Houses throughout the world.

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- Palmetto Packing
- Fairbanks Scales

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Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Fort William Winnipeg Regina Saskatoon
Calgary Edmonton Vancouver Victoria

TEST DATA

Continued from March 20

Quality of Steam
(40) Live steam:—
(a) Moisture in steam .....per cent.
(b) Superheat .....deg. fahr.
(c) Factor of correction for quality of steam .....
(41) Exhaust steam:—
(a) Molsture in steam .....per cent.
(b) Factor of correction for quality of steam .....

	Total Lbs. Lbs. per hr.	
Total Quantities—		
(42) Live steam to heaters	....	....
(43) Live steam to effects	....	....
(44) Live steam to pumps	....	....
(45) Total live steam supplied to entire apparatus (sums of Items 42, 43 and 44)	....	....
(46) Equivalent weight of total live steam from and at 212 deg. fahr.	....	....
(47) Exhaust steam to heaters	....	....
(48) Exhaust steam to effects	....	....
(49) Total exhaust steam	....	....
(50) Feed liquor	....	....
(51) Discharge liquor or concentrated product	....	....
(52) Steam to condenser	....	....
(53) Evaporation from liquor	....	....
(54) Equivalent evaporation from liquor from and at 212 deg. fahr.	....	....
(55) Equivalent evaporation from liquor, from and at 212 deg. fahr., per sq. ft. of the total heating surface in all the effects	....	....
(56) Liquor entering:—		
(a) 1st effect	....	....
(b) 2nd effect	....	....
(c) 3rd effect	....	....
(d) 4th effect	....	....
(e) 5th effect	....	....
(f) 6th effect	....	....
(57) Liquor leaving:—		
(a) 1st effect	....	....
(b) 2nd effect	....	....
(c) 3rd effect	....	....
(d) 4th effect	....	....
(e) 5th effect	....	....
(f) 6th effect	....	....
(58) Evaporation from liquor in:—		
(a) 1st effect	....	....
(b) 2nd effect	....	....
(c) 3rd effect	....	....
(d) 4th effect	....	....
(e) 5th effect	....	....
(f) 6th effect	....	....
(59) Self-evaporation in:—		
(b) 2nd effect	....	....
(c) 3rd effect	....	....
(d) 4th effect	....	....
(e) 5th effect	....	....
(f) 6th effect	....	....
(60) Water discharged from:—		
(a) 1st heater	....	....
(b) 2nd heater	....	....
(c) 3rd heater	....	....
(d) 4th heater	....	....
(e) 5th effect	....	....
(f) 6th effect	....	....
(61) Condensed steam drained from:—		
(a) 1st effect	....	....
(b) 2nd effect	....	....
(c) 3rd effect	....	....
(d) 4th effect	....	....
(e) 5th effect	....	....
(f) 6th effect	....	....
(62) Condensing water	....	....

(63) Heat above 32 deg. fahr. contained in entering liquor .....B.t.u.
(64) Heat from steam supplied to entire apparatus, including pumps. (Calculated from total live steam) .....B.t.u.
(65) Heat to pumps .....B.t.u.
(66) Heat above 32 deg. fahr. contained in discharge liquor .....B.t.u.
(67) Heat contained in steam to condenser. B.t.u.
(68) Heat contained in the evaporation from liquor .....B.t.u.
(69) Heat contained in entrained product escaping with steam to condensers ...B.t.u.
(70) Heat supplied to the heaters.....B.t.u.
(71) Heat above 32 deg. fahr. in water discharged from heaters.....B.t.u.
(72) Heat supplied to effects by live and exhaust steam .....B.t.u.
(73) Heat above 32 deg. fahr. contained in the condensed steam drained from the effects .....B.t.u.
(74) Heat discharged from the effects.....B.t.u.

Evaporation Ratio and Efficiency of Individual Effects—
(75) Overall thermal efficiency of entire equipment .....per cent.
(76) Thermal efficiency of each effect...per cent.
(77) Thermal efficiency of the heaters...per cent.

Capacity—
(78) Evaporation per hour from and at 212 deg. fahr. ..... lb.
(79) Raw liquor to apparatus per 24 hours..gal.
(80) Concentrated product per 24 hours....gal.
(81) Apparent heat-transmission co-efficients:—
(a) For 1st effect .....
(b) For 2nd effect .....
(c) For 3rd effect .....
(d) For 4th effect .....
(e) For 5th effect .....
(f) For 6th effect .....
(82) Corrected heat-transmission co-efficients:—
(a) For 1st effect .....
(b) For 2nd effect .....
(c) For 3rd effect .....
(d) For 4th effect .....
(e) For 5th effect .....
(f) For 6th effect .....

Economy—
(83) Evaporation per pound of total steam used ..... lb.
(84) Concentration product per pound of total steam used ..... lb.
(85) Evaporation per pound of steam from and at 212 deg. fahr. ..... lb.

Heat Balance—	B.t.u. Per hr.	Per cent.
(86) Heat to pumps, heaters, and effects:		
(a) Heat from steam to entire equipment (item 64)	....	....
(b) Heat above 32 deg. fahr., contained in entering liquor (item 63)	....	....
Total = (a) + (b)	....	....
(87) Heat discharged from heaters and effects:—		
(a) Heat in water from heaters (item 71)		
(b) Heat in condensed steam drained from effects (item 73)	....	....
(c) Heat in steam condenser (item 67)	....	....
(d) Heat in entrained product (item 69)	....	....
(e) Heat in discharge liquor (item 66)	....	....
Total = (a) + (b) + (c) + (d) + (e)	....	....
(88) Radiation and unaccounted-for losses:—		
[Item (86) Total — Item (87) Total]	....	....

Liquor Analysis—
(89) Analysis of feed liquor.
(90) Analysis of discharge liquor.
(91) Analysis of liquor out of each effect.
(92) Analysis of steam to the condenser to determine the amount of entrained product.

Physical Properties of Liquor—
(93) Specific gravity of feed liquor.
(94) Specific gravity of discharge liquor.
(95) Specific heat of feed liquor.
(97) Specific heat of discharge liquor.
(98) Specific heat of liquor out of each effect.

(Signed)
E. N. TRUMP, chairman.
B. N. BUMP.
E. A. NEWHALL.
H. L. PARR.
L. C. ROGERS.

The Toronto Board of Control, acting on the recommendation of the property commissioner, will oppose the application to the legislature for a bill which proposes to exclude brick yards from the operation of the smoke by-law.

Two gasoline engines of 200 horsepower each have been installed in the pumping station of the Pembroke waterworks, in conjunction with two De Laval centrifugal pumps, having a capacity of 800 gallons per minute. The installation was made by the Turbine Equipment Co. of Toronto.

The Montreal Chambre de Commerce has been considering the advantages that would follow the building of a tunnel under the Champ de Mars and Jacques Cartier Square, for the purpose of relieving the congestion that frequently occurs in this vicinity on market days and when traffic to and from the harbor front is excessive. No definite action has been taken but the project has been laid before the Administrative Commission.

Auto Supplies Co., Ltd. Incorporators: Henry Howard Shaver, barrister-at-law; Alexander Findlay Boyle, automobile builder; and others, all of Toronto. Capital $150,000, divided into 1,500 shares of $100 each. Head office Toronto.

The Imperial Oil Co., Ltd., are planning to erect a two-story, fireproof office, a large two-story fireproof garage, boiler and pump house and a plant for the repair and care of barrels, at Brandon, Man. Two ten-thousand barrel tanks will also be installed and the necessary lubricating storage plants. It is expected construction will begin in the spring and be completed in the fall of 1921.

To Make Matches. — Sir Alexander Maguire and his brother Dr. D. P. Maguire, who have been in Montreal at the Ritz-Carlton Hotel in connection with the plans for the erection of a match factory plant to be operated by the British firm of Maguire, Paterson and Palmer, Limited, have left for New York, where they will embark on the Olympic for Southampton. They expect to return in about three weeks to complete all details of their plans.

Erecting Big Plant.—Announcement is made of the sale in Toronto of five acres of land at the corner of Hanson Street and Coxwell Avenue, where there is at present a Grand Trunk Railway siding. Plans and specifications have been prepared for the erection of a modern daylight plant of the best brick and mill type construction. The cost of the building will be in the neighborhood of half a million dollars. The main building will be 500 feet long and 80 feet wide. Upon completion three companies will commence operations in the buildings: Crouse-Hinds Company of Canada; Harvey-Hubbell, and the Hubbell-Mack Machine Screw Company. The new plant is not expected to commence operations until November 1, 1921.

The Engineering Equipment Company, Limited, sales engineers, dealing in mining, contracting and industrial machinery and supplies, have opened offices at 263 St. James Street, Montreal. The company has secured the exclusive selling rights for many leading lines of such equipment from firms in the United States and Great Britain, as well as many in Canada. The officers of the new company are: president, Norman M. Campbell, late general sales manager of the Canadian Ingersoll Rand Company; vice-presidents, Samuel Seaver, formerly Canadian sales manager for Sullivan Machinery Company and Canadian Rock Drill Company of Toronto; and Fred H. McKechnie, of McKechnie & McLaren, sales engineers of Montreal. Percival J. Woolf, late manager of the General Electric Company at Duluth, is the secretary-treasurer.

Making Radiation Usable

All who specify and install radiation are agreed upon one point: radiators cannot do their work when they are choked up with air and water.

The two curves are from actual laboratory tests and the same radiator, fitted with two kinds of radiator traps—one of which was the Dunham Radiator Trap—the trap that has been making radiators practically 100% hot since 1903.

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Making radiation usable is as commendable as the conservation of coal.

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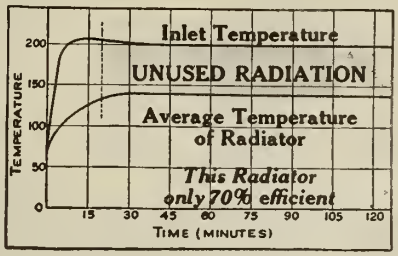
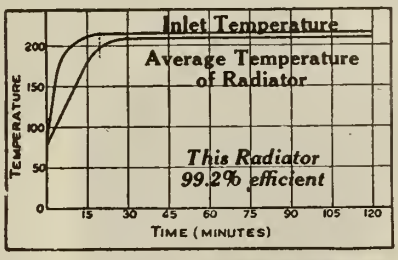
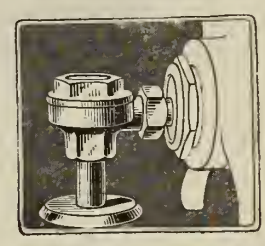




The Dunham Radiator Trap



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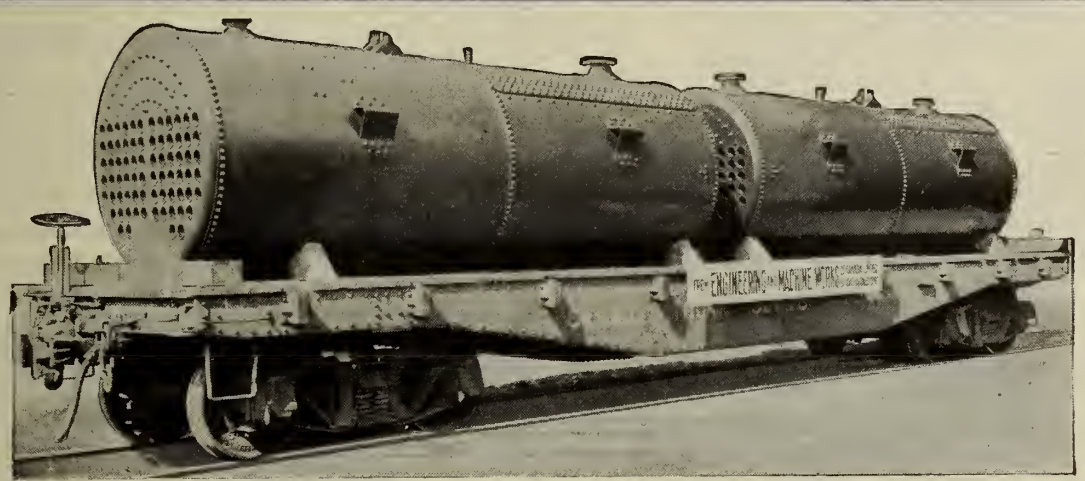

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THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electricol Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

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New York, U.S.A.

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1¼-in.	27 25	.....
1½-in.	26 25	29 50
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2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
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Price List No. 38

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Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger, net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse	base $7.00

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15
Standard	0 15 to 0 40
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅝-in. and less	15
Carriage bolts, 7/16 and up	Net
Coach and lag screws	20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	5
Machine bolts, ⅜-in. and less	30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 27½
Solder, guaranteed	29½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 3
Pure turp., single bbls., gal.	1 2
Linseed oil, raw, single bbls.	1 0
Linseed oil, boiled, single bbls.	1 0
Plaster paris, per bbl.	4 5
Sandpaper, B. & A.	list, plus 4
Emery cloth	list, plus 37½
Sal soda	0 0
Sulphur, rolls	0 0
Sulphur, commercial	0 0
Borax, crystal and granular	0 1
Wood alcohol, per gal.	2 7
Whiting, plain, per 100 lbs.	3 0

COPPER PRODUCTS

	Mont.	Toron
Bars, ½ to 2-in.	$32 00	$34
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	34 00	38
Copper sheet, tinned, 14 x 60, 14-oz.	40 00	42
Copper sheet, planished, 16-oz. base	46 00	48
Braziers', in sheets, 6 x 4 base	38 00	41
Copper tubing, seamless	0 43	0

RUBBER BELTING

Standard	1
Best grades	1

WASTE

XXX Extra	21	Atlas	1
Peerless	22	X Empire	1
Grand	21½	Ideal	1
Superior	21½	X Press	1
X L C R	14½		

Colored

Lion	13½	Popular	1
Standard	12	Keen	
No. 1	14		

Wool Packing

Arrow	35	Anvil	2
Axle	28	Anchor	1

Washed Wipers

Select white	20	Dark colored	0
Mixed colored	10		

This list subject to trade discount f quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 3
Plumbers' oakum, per lb.	0 1
Packing, square, braided	0 3
Packing, No. 1 Italian	0 4
Packing, No. 2 Italian	0 3
Pure Manila rope	2
British Manila rope	2
New Zealand hemp	2
Transmission rope, Manila	0 4
Cotton rope, ¼-in. and up	0 8

METALS

	Gross Mont.	Toront
Tin	$39 00	$40
Spelter	7 75	7
Lead	5 75	7
Antimony	8 00	8
Aluminum	34 50	30

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toron
Sheets, 3 lbs. sq. ft.	$10 50	$14
Sheets, 3½ lbs. sq. ft.	10 25	14
Sheets, 4 to 6 lbs., sq. ft.	10 00	13

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

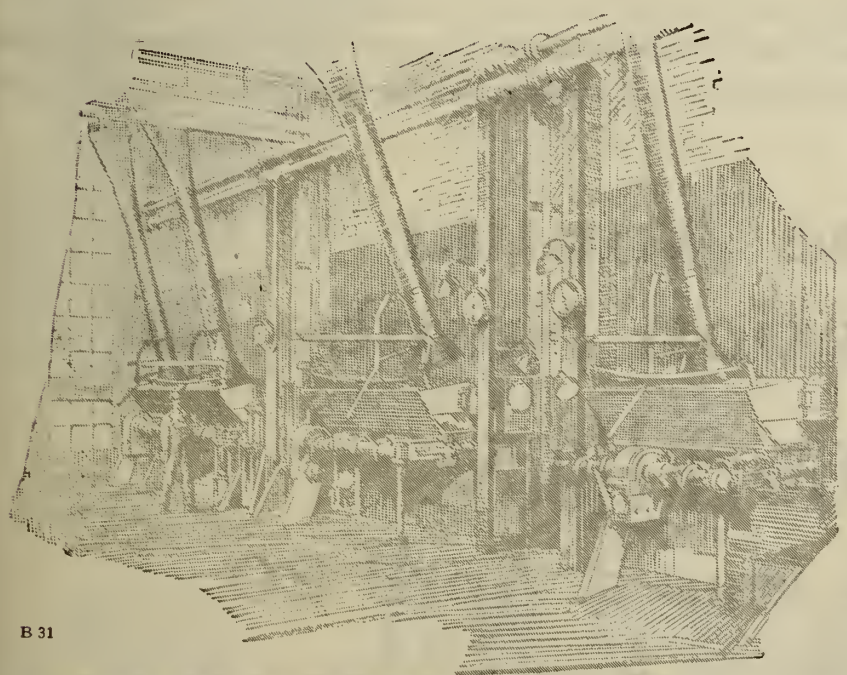
Worthington builds every type of boiler feed pump

POWER plant engineers and managers benefit by the Worthington policy of building every type in each of its lines of equipment.

Take for instance the Worthington boiler feed line. Steam pumps include single and duplex, horizontal and vertical types in pot valve plunger and standard piston models for all ranges of pressure. Similarly, Worthington centrifugal pumps are built in patterns to meet the varying conditions of temperature and pressure found in boiler feed work.

This policy of manufacturing every type of a given equipment assures to the buyer impartial advice on his selection.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities



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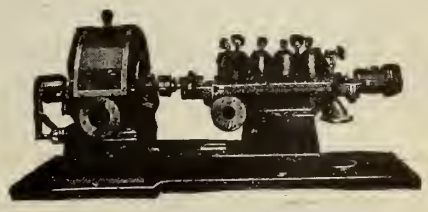
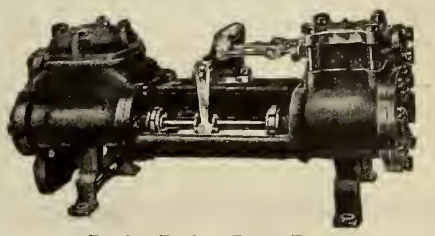
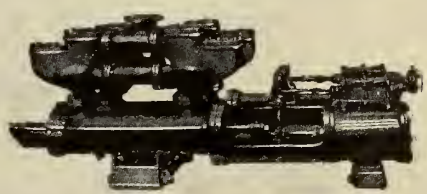


Double Suction Turbine Pump, Boiler Feed Pattern

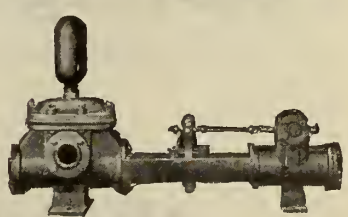
Centrifugal pumps often become steam bound while handling hot water. Under such conditions, the rotating element of the average pump may seize at close clearance points. Worthington double suction centrifugal boiler feeder is equipped with a special floating sealing ring which prevents this binding.



Duplex Packed Piston Pump



Pot Valve Boiler Feed Pump



Single Horizontal Simplex Pump —Piston Pattern

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*

"KYMBALA"

AN IDEAL JOINTING

IT would be folly to contend that no further improvement is possible in jointing material, but "Kymbala," manufactured from Blue or South African Asbestos Fibre, is now widely admitted to be a great improvement on all Jointings hitherto manufactured. Its advantages may be summed up as follows:

PURITY.—Blue Asbestos contains only 4% impurities against 15% in the best White Asbestos Fibre.

TOUGHNESS.—Blue Asbestos is of double the tensile strength to White Asbestos.

PRESSURE-RESISTANCE. — Blue Asbestos Fibre is admittedly the hardest and most resilient Asbestos Fibre extant, besides being water and steam-resisting, and can absolutely be relied upon not to "blow out."

DURABILITY.—Owing to its great purity, strength and pressure-resistance, it has proved to last easily more than double the time of other high grade jointing, thus considerably reducing stoppages, labour and material.

WEIGHT.—"Kymbala" is the lightest Jointing, hence means a reduction in cost. Put it to the test, you'll find it the best in every way.

Samples for trial will be supplied on application to the sole Manufacturer

BELDAM ASBESTOS (CANADA) COMPANY

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QUEBEC and N.B., Universal Supplies Limited, Coristine Bldg., Montreal, Que.

IF IT'S MADE OF ASBESTOS WE CAN SUPPLY IT

The Annual Refrigeration Number of

POWER HOUSE

Will Be Issued April 20

This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the REFRIGERATION NUMBER

"Belting trouble ends where D.K.McLaren's Belting begins"

"Cheap" Belting

The flawless back leather of selected hides, tanned by the Genuine British Oak Process—made so pliable, so tough and durable as to be practically slipless, stretchless and unbreakable—this is D. K. McLaren's Leather Belting. Wouldn't you consider it "cheap" at almost any price?

And yet we have made it possible to manufacture belting such as this and sell it at prices which are as low as any on the market—quality considered.

Truly D. K. McLaren's Belting is the royal road from the source of power to pulley, for it delivers power with the least loss—and gives a minimum of trouble doing it.

GENUINE OAK

D·K·McLAREN LIMITED

GENUINE OAK

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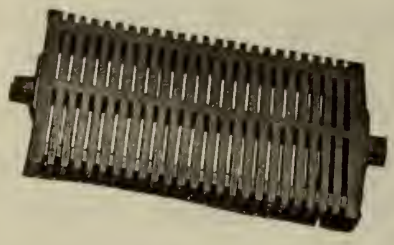
CYCLONE GRATES



Don't Waste Your Fuel

The 90 per cent. under-draught and 60 per cent. air space of Cyclone Grates mean practically no clinkers—even when you burn screenings and other low grade fuels.

Their jarring, shaking movement sifts **all** the ashes through; and **all** the good fuel remains.

You **need** Cyclone Grates, and if you need a thing you pay for it whether you buy it or not. Our 30 days' free trial offer will convince you. Why not write to-day for full particulars?

The Canadian Steam Boiler Equipment Co., Limited

Sole Makers for Canada

20 McGee Street **Phone G. 3660** **Toronto, Ont.**

AGENTS:

ST. JOHN, N.B.; F. W. Blizard, 329 Charlotte St. MONTREAL: Mason Regulator Co., Ltd. St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St. WINNIPEG: Vulcan Iron Works. OTTAWA: Campbell Steel & Iron Works, 855 Carling Ave.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Jenkins Valves

Made *for* Maximum Service

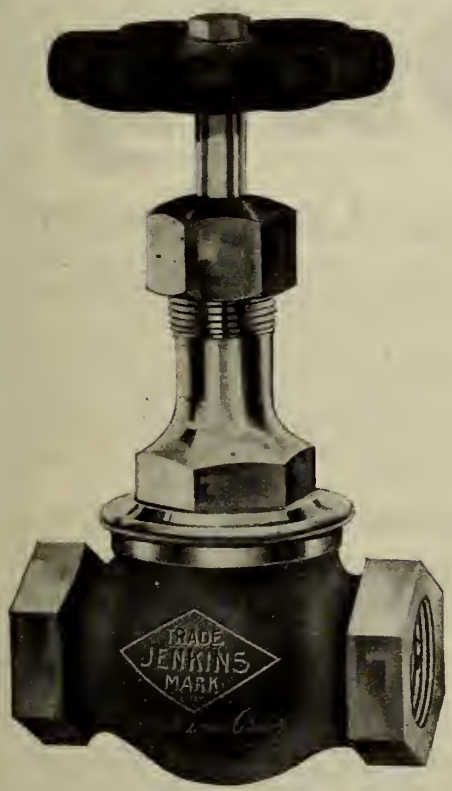


Fig. 105
JENKINS BRASS GLOBE VALVE
Suitable for 175 lbs. Working Steam Pressure or 250 lbs. Working Water Pressure.

The dependability and longevity of genuine Jenkins Valves are due to the fact that every valve in every type is made for the Maximum Service.

The man who knows valves and valve requirements installs Jenkins. Their trouble-free record in every branch of Service is a guarantee of satisfaction even under unusually severe conditions.

Jenkins Valves for every service are obtainable at supply houses everywhere. The line is very complete, including valves of brass, iron and cast steel for all requirements of power plants, industrial establishments, plumbing and heating service, etc. When buying look for the name "Jenkins" within a Diamond Mark on the body of the valve. It's there for your protection.

Catalog No. 8 describes the entire Jenkins line. Send for free copy.

Jenkins Bros.
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TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal Can.
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AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

TRADE JENKINS MARK Jenkins Bros

High-Duty

—The Short Cut to Low Cost Power

HAVE you a definite conception of just what "high-duty" means as applied to the Jones "A-C" (Automatic-Cleaning) Stoker?

High-Duty Implies first of all, ability to meet any conceivable load condition, whether a steadily maintained overload or a widely fluctuating load where enormous peaks must be met almost momentarily. The automatic-control of fuel and air, and individual control of retorts embodied in the Jones "A-C," makes this a certain result.

High-Duty Means not merely heavy overload capacity, but ability to maintain overloads continuously without shutdowns and with minimum maintenance costs. The automatic-cleaning ("A-C") feature, the absence of clinker on side and bridge walls, and the rugged simplicity, making repairs almost negligible, insures *continuous operation at all loads.*

High-Duty Signifies not alone maintained overload capacity, but ability to fulfill this condition while burning every and any grade of fuel. The underfeed principle (a *Jones* principle) as perfected in the Jones "A-C," adapts this stoker to coals of every firing characteristic.

High-Duty Summarizes the features that have given the Jones "A-C" a wider range of utility recorded in greater return on stoker investment in plants of every size. The new "A-C" catalog goes into detail.

The services of an old-established and newly re-organized and expanded engineering organization—formerly the Jones Under-Feed Stoker Company, Limited, and now the Under-Feed Stoker Co. of Canada, Limited—are at your disposal. Request (without obligating yourself in any way) the new "A-C" catalog.

The Under-Feed Stoker Co. of Canada, Ltd., 81 Victoria St., Toronto

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Coristine Bldg., Montreal, Que.

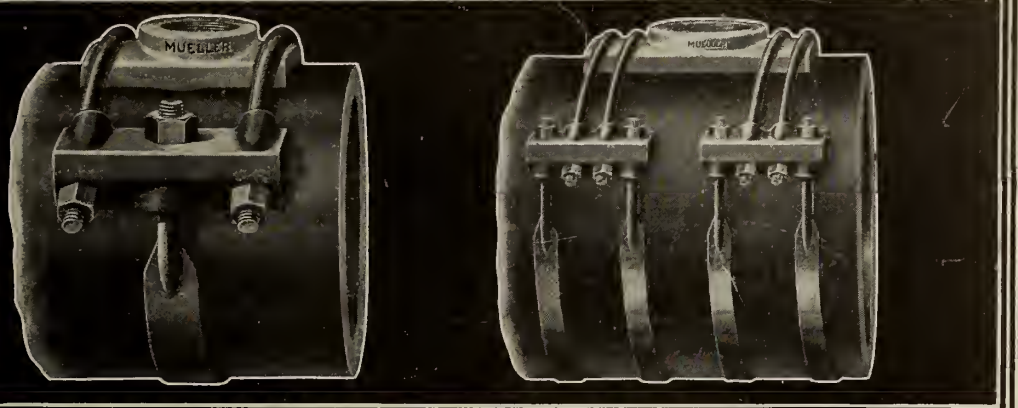
Alberta and Saskatchewan:
Mr. J. Twooney,
Camrose, Alta.

British Columbia:
E. A. Earle Limited,
739 Hastings St. W., Vancouver, B.C.

Jones "A-C"

Automatically-Cleaned ***Automatically-Controlled***

JONES STOKER



Dependable Service Means Real Economy

For carrying service from wrought-iron or light-weight mains—thru threaded connections that insure dependable service—there is nothing equal to

MUELLER Service Clamps

The straps are all hand-forged, soft steel—with threads and nuts accurately cut. The malleable clamps are galvanized by the hot process, which fills all pores and prevents leaks.

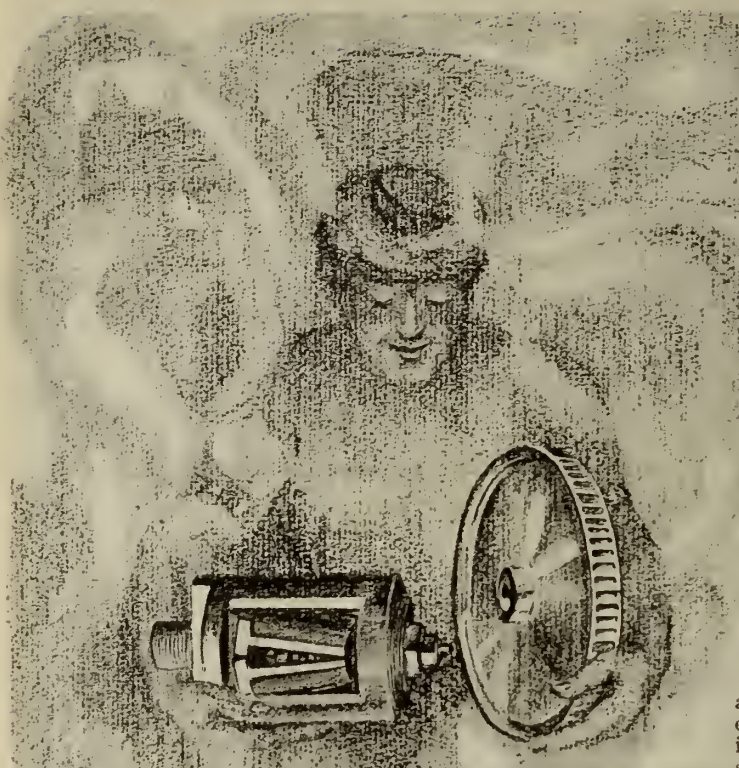
Write for catalog and prices. Mail orders given immediate attention.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools

American Factory at Decatur, Illinois, U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.



Sturtevant
(TRADE MARK)
TURBINES

Anticipate New Demands for Economy

Demands made to-day of turbines designed for driving fans, blowers, generators and pumps are more exacting than ever before, consequently turbines built to meet requirements of the past, cannot compete with those built for modern conditions.

Sturtevant Type 10 Turbine

anticipates these ever changing requirements and gives economical and dependable service regardless of the range in load. Continuous operation is assured with minimum steam consumption.

The nozzles and reverse buckets are features worthy of mention when the advantages of Sturtevant Turbines are considered. By simply closing a hand valve each individual nozzle can be cut out of service. This makes it possible for light loads to be carried without shutting off the main steam supply. The buckets are made from tobin bronze, carefully fitted and polished to reduce steam friction. Milled into the rim by our own patented process.

The emergency valve assures reliability. It is connected to an emergency governor and when a predetermined speed is exceeded, closes instantly and automatically. This turbine has been twelve years on the market. In horsepowers from one to five hundred.

Our engineers solicit your correspondence in regard to applying Sturtevant Turbines to your particular needs.

Send for catalog 256N for detailed description of construction.

B. F. Sturtevant Company of Canada, Ltd.

Main Office and Works:
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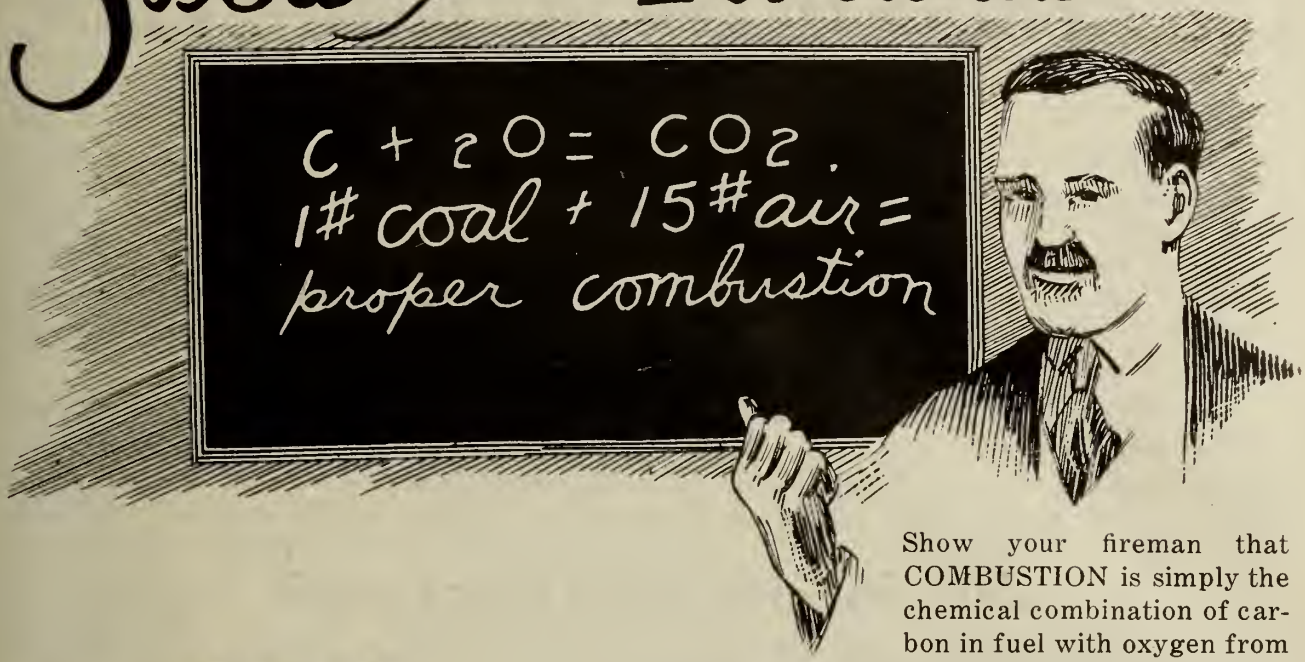
Sales Offices:
TORONTO and MONTREAL

Show your Fireman



Show your fireman that COMBUSTION is simply the chemical combination of carbon in fuel with oxygen from the air; that perfect combustion consists in bringing together the proper proportion of each, and that too much draft means a lot of extra air to be heated up to 500° or more with heat that might just as well produce steam.

Hays Draft Gage

Then equip each boiler with

HAYS DRAFT GAGE and HAYS AUTOMATIC CO_2 and DRAFT RECORDER

and both you and your fireman will know what is happening in the boiler room. Your fireman will be able to make the proper adjustments to better his efficiency. He will not have to guess. He will know when, how and why to act. Naturally he will take a new interest in his work—if you will but do your part.

Back of all Hays Apparatus is "Hays Service" which may be worth as much as the actual equipment. This service includes expert inspection of your plant and advice and instructions as to just what you need and how to install and derive the greatest benefit from it.

Hays Automatic CO_2 and Draft Recorder

Awarded Certificate of Merit by Franklin Institute

The Jos. W. Hays Corporation

Combustion Efficiency Appliances

1060 E. Eighth St.

Michigan City, Indiana

Carrying On By Marking Time

By J. K. Munro

HAY foot—straw foot—left foot—right foot—and never getting anywhere! That's J. K. Munro's view of the Parliament at Ottawa during March. Crerar and Lapointe are the only men who have really said anything, in "J. K.'s" opinion. After a survey of the Dominion Mr. Munro prophesies that there will be a Farmer Government, sure, in 1922—and probably supported by several French-Canadians.

And the Budget—"it is not likely," says Canada's leading political pundit, "that it will be a very sweeping document. It will likely provide for a sales tax of about one per cent, to make up the hundred million by which the estimates exceed the revenue, and the excess profits tax will likely be wiped out. That's about all."

John Barleycorn and Jack Canuck

It's a hard question for the man-on-the-street to answer, How Dry is Canada? But Charles Christopher Jenkins has studied the question from all angles, and you will find his article extraordinarily informative and—in the light of Ontario's vote April 18—very timely.

"For Sale For a Song."
By Agnes C. Laut.

The question whether Oriental labor will solve some of our problems is here discussed.

"From Ontario to Tin Pan Alley."
By Geoffrey O'Hara.

A Canadian wrote "K-K-Katy" and also a song for Caruso. He tells how he won success.

"The Drama of Our Great Forests."
By Arthur Heming.

A further instalment of the artist-author's adventures with Oo-koo-hoo in Canada's primitive Northland.

"As a Man to His Friend."
By William Merriman Rouse.

A stirring story of the Ottawa Valley, of two lumberjacks, an actress and a barber.

"Linen Sheets."
By Alan Sullivan.

What do the occupants of an Old Woman's Home think of, as they wait for the "Reaper"? A poignant story with a surprise climax.

"Pawned."
By Frank L. Packard.

John Bruce recovers his strength, woos Claire Veniza only to find her falling into Dr. Crang's clutches.

"Why Have We Juvenile Crime?"
By Ethel M. Chapman.

A timely account of Juvenile Delinquency and the Big Brother Movement.

REVIEW OF REVIEWS

U.S. Foreign Policy and Britain ..... John H. Latane
Unemployment Crisis in Britain ..... R. H. Tawney
Optimistic About the League ..... Lord Robert Cecil
Ideal British Cabinet ..... London Magazine
Common Sense Bridge ..... A. E. Manning Foster
Kipling's "Lurgan Sahib" Dies ..... London Times
U.S. a Bar to Naval Disarmaments ..... Scientific American
A Winged Torpedo Boat ..... "Tin Fish"
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MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"

"A ½" diameter valve stem leaking all around "the stuffing box will blow about 40 pounds of "steam per hour; with 100 pounds pressure in "the valve. Ten stuffing boxes leaking for one "full day will waste 1,600 pounds of coal."

The Valve World, November, 1920.

DON'T WASTE STEAM - - AVOID CONSTANT REPACKING

BRAIDED FOR RODS

Use "PALMETTO" PACKING

TRADE MARK

REG U S PAT OFFICE

TWIST FOR VALVE STEMS

It is made to give long service even under hard conditions. The lubricant in each single strand keeps it from hardening.

LONG SERVICE MEANS REAL ECONOMY

Let us send you working samples to test for yourself—no charge.

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109 DUANE ST. NEW YORK

Canadian Agents: The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

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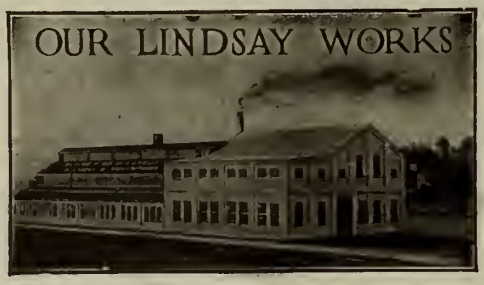
Water Turbines, Hydraulic Governors, Centrifugal Pumps



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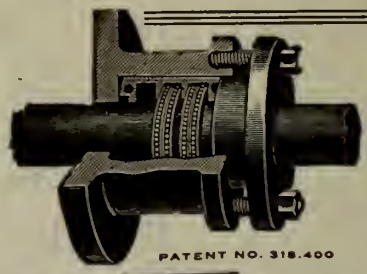
Lindsay, Ontario



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,068
" "	775 193	" "	905,106
" "	775,194	" "	934,629
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Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

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Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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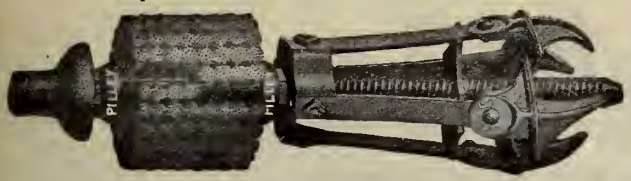

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Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over.
A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
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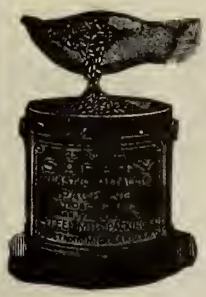

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For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

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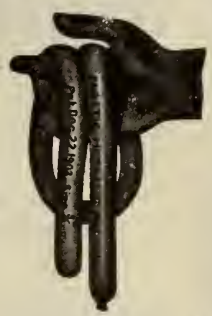

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Accuracy!

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When you install an American Gauge you know that it will prove dependable because you know that it is conscientiously as well as scientifically built.

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At every point, ACCURACY. And along with Accuracy, the durability that assures long service.

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Better Tools Make Better Workmen

"W & B" Machinists' Knife Handle Wrenches —Made in Canada— 7 sizes, 6 to 21 inches— at your dealer's.

DROP-FORGINGS
Often Cheaper than Castings
— Always Far Superior —

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By properly metering steam flow, Republic Flow Meters give you **Fuel Efficiency**, **Boiler Efficiency** and **Plant Efficiency**. By conserving steam the Republic saves fuel.

Republic Flow Meters

The Republic gives you a complete "accounting record" of your entire plant on a conveniently located instrument board. This is made possible by its exclusive feature — **Electrical** operation.

Republic Flow Meters Co., of Canada, Ltd.

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See Page 75

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CO_2 Indicator for boiler front guides the fireman in saving coal

The Big Boiler Room Waste

is the heat discharged up the chimney

UEHLING CO_2 EQUIPMENT

keeps tabs continuously (not intermittently) on this waste, thus enabling engineer and firemen to co-operate in reducing it. Uehling CO_2 Equipment is simple in principle and operation and uses no chemical solutions.

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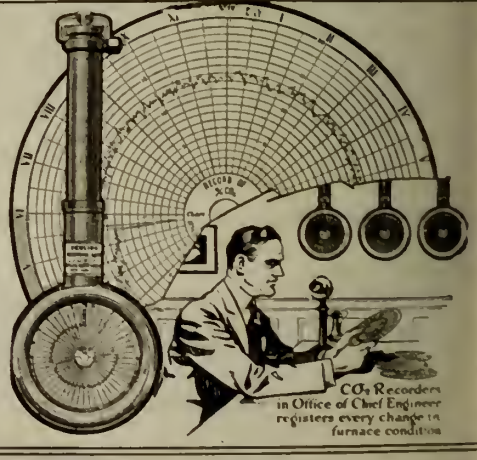

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UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube
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We specialize in the making of

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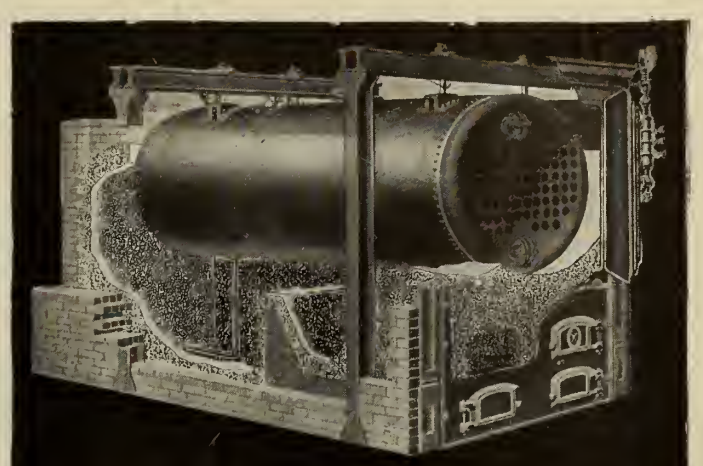

SMILES AT HIGH HEAT

Boiler furnace linings moulded into place, forming a solid, one-piece monolithic lining, will withstand the variations and extremes of heat under continuous service, when the proper lining material is used, viz:—

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There is only ONE Plastic Fire Brick and it comes to you in barrels in a moist, plastic condition, ready for use. Any intelligent person can do the work, no special tools, forms or skill is required.

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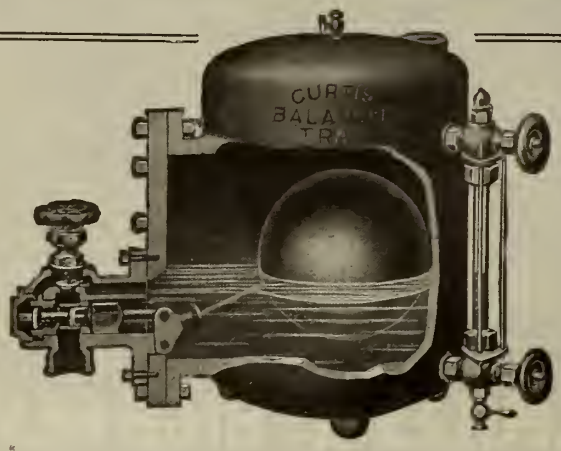

Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
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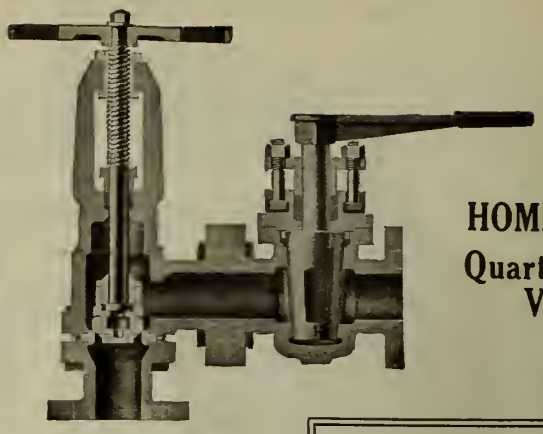

HOMESTEAD Quarter Turn Valve

HOVALCO Renewable Blow-Off Valve

A Reliable Combination

This absolutely dependable combination consisting of the "Hovalco" Blow-Off Valve and the "Homestead" Quarter Turn Valve ends every blow-off trouble.

The **"Hovalco" Blow-Off Valve** is made with an extra heavy, semi-steel body. Both the valve disc and the seat are made of special alloy. The removal of four bolts gives perfect access to every part.

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STERLING ENGINE COMPANY.

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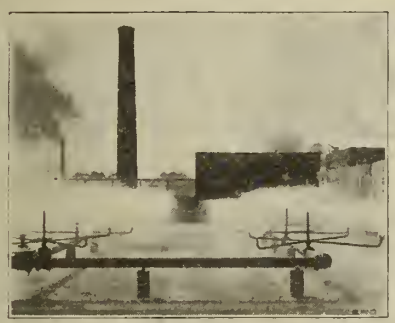

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Harrisburg, Ill. Capacity 10,000
G.P.M.

SPRA-RITE
Two-Vane Nozzle

The function of the SPRA-RITE is to discharge fine spray of equal density throughout its entire cross section.

Cooling Systems for Cooling Condenser Water

Meet Modern Conditions—Cut the Costs

COOLING systems representative of the best practice a decade ago are virtually obsolete now. "The SPRA-RITE" System fills the bill to-day, meeting as it does all the requirements in the shape of capacity, flexibility and cooling efficiency.

SPRA-RITE Cooling Systems have proved their efficiency. Tests made on the coal pile by means of the increased vacuum obtained prove that many systems have made a 50 to 100 per cent. return on the original investment in a year's time. Frequently a reduction in insurance rates is also obtained by reason of ample water supply close at hand for use by fire pumps.

For steam condensing equipment, SPRA - RITE Cooling Systems represent the highest standard of efficiency, but a spray cooling system will show its highest efficiency only when equipped with SPRA-RITE Nozzles, which were primarily designed for this application.

Owing to the rapid adoption of the Steam Turbine and Steam Condensation Equipment water cooling has become a factor of great importance to the manufacturer.

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For this reason plant sites within easy reach of natural bodies of water for condensation are in demand. But such sites are not always available. It is then necessary to install Spray Cooling Ponds for cooling the condenser water so that the available supply can be used over and over again.

Spray ponds vary in construction. Concrete ponds are the most popular, but natural ponds, earthen basins and roofs may be utilized. We will recommend and furnish plans to suit your conditions.

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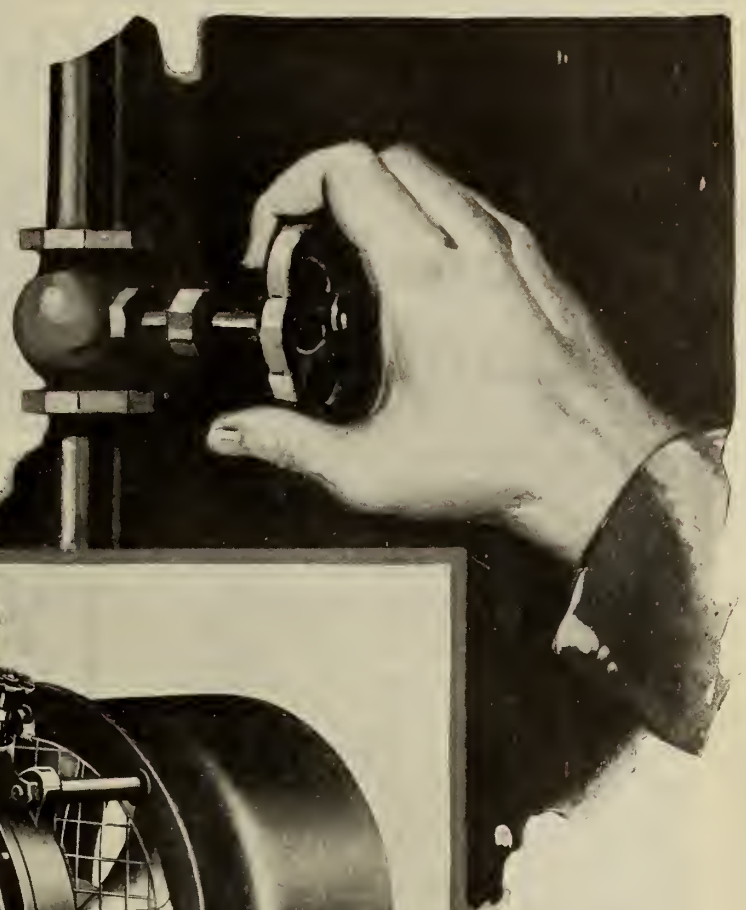
The

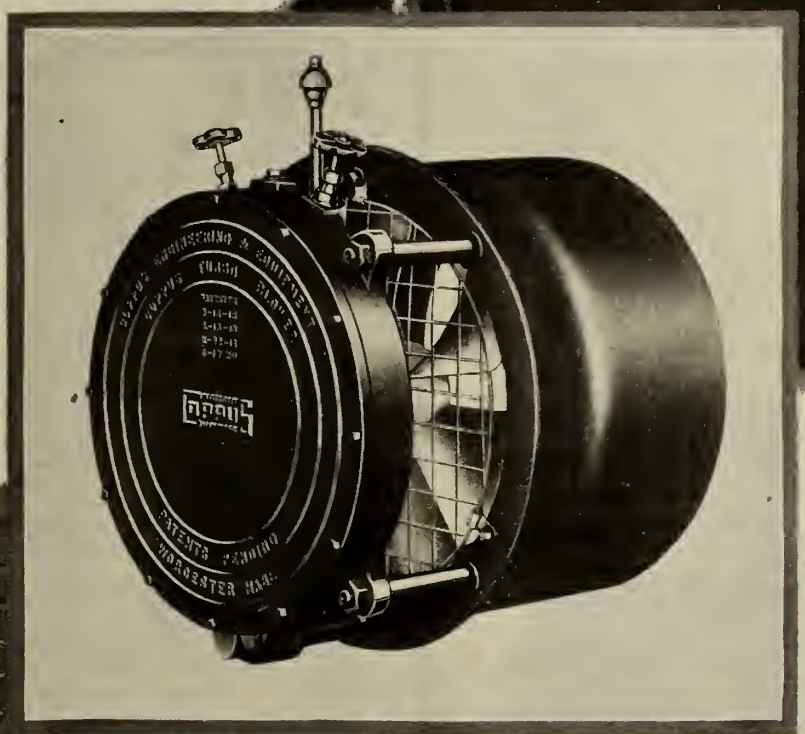
REGISTERED COPPUS U.S. PAT. OFFICE

Turbo Blower will give you Valve-Control of your fire



ONCE unheard of — to-day standard practice in our most efficient boiler plants—*valve control of your fires.*

A turn of the valve gives an immediate "pick-up" of your fires. More steam in a hurry—and; mind you, the cheapest and poorest grades of coal can be successfully burned.



It is almost as easy to install a Coppus Turbo Blower under your boilers as it is to put an electric fan in your office. Merely cut a hole in the boiler setting—mason in the casing—make the simple steam connection, and it's done. Then you have valve-control of your fire—as easy as regulating the flame of a gas jet.

Coppus Turbo Blowers are standard equipment in efficiently operated boiler plants.

Our booklet contains interesting blower data. Ask for it.

Coppus Engineering & Equipment Co.

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PETRIE

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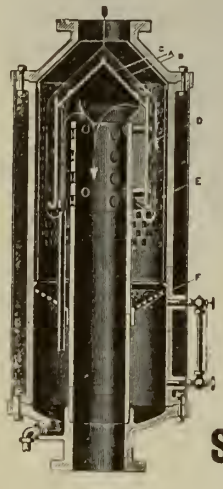
TO CONSIDER ABOUT A SEPARATOR



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II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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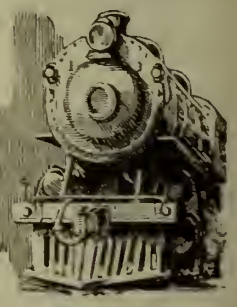
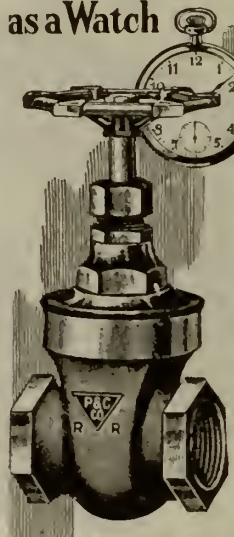
STRONG as a Locomotive
FINE as a Watch





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Old-time users of Pratt & Cady Valves who have found valves in their plants as good as the day they were installed, thirty or forty years before, marvel at their durability.

But when you consider their massive construction, the superior grades of metal used, the painstaking labor expended on their construction, and the renewable disc (or renewable seat) feature which practically makes a new valve out of a Pratt & Cady Valve that has seen long service, there is every reason why they should last indefinitely.

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PRATT & CADY
RENEWABLE VALVES

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This is particularly true in the steel industry, where in addition to the incentive of fuel saving resulting from the maintenance of clean heating surfaces in the boilers, there is the further important consideration of keeping machinery in all departments operating at full capacity,—a result generally possible only when boilers are operating at highest ratings and efficiencies.

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Among a few of the several hundred iron and steel plants which are increasing dividends with Diamond Soot Blowers, the following are typical :

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Lukens Steel Company	Bethlehem Steel Company
American Rolling Mill Company	Trumbull Steel Company
Illinois Steel Company	Atlantic Steel Company
Donner Steel Company	American Steel Company
Wisconsin Steel Company	Ohio Forge Company
Pittsburgh Steel Company	Midvale Steel Company

If your boilers are not equipped with Diamond Soot Blowers you can profitably follow the example of the big steel mills.

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DIAMOND SPECIALTY COMPANY
WINDSOR, ONTARIO

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

Extravagance Must Stop!

THE COPES Boiler Feed REGULATOR

is a vital organ in the system which draws the latent energy out of the coal pile and delivers it at the bus bar or the main drive shaft.

Without the Copes Boiler Feed Regulator none of the other organs can perform its function properly. Stokers, feed water heaters, water softeners, and the boilers themselves cannot do their best without proper feed water regulation. The legibility of steam and water flow records, pressure and temperature charts, all depend more or less on scientific feed water regulation.

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Durabla Mfg. Co., New York, N.Y
Garlock Packing Co., Hamilton, Ont.

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Pratt & Cady Co., Inc., Hartford, Conn.

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Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Co., Toronto.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
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Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Paper Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Coppus Eng. & Equip. Co., Worcester, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

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Jointless Fire Brick Co., Chicago, Ill.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
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Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
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BOILER FITTINGS
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Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

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Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Gates Refractories, Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
Green's Economiser, Ltd., Toronto.

BOILER METAL TREATMENTS
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BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto

BOILER METERS
Bailey Meter Co.

BOILER PRESERVATIVES
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Beveridge Paper Co., Ltd., Montreal.
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Cole, Ltd., Geo. W., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
R. C. Miller Oil & Supply Co., Ltd., Montreal
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Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Judd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
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Holden Co., Limited, The, Montreal.

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
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Ministry of Munitions, London, England
Montreal General Tool Co., Montreal, Que
Waterous Engine Works Co., Brantford

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The Vulcan Soot Cleaner Co., Du Bois, Pa

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Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal

BRASS PIPE AND TUBE
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Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

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Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
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Jas. Morrison Brass Mfg. Co., Toronto.

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Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont
Norwalk Iron Works, South Norwalk, Ct
Empire Mfg. Co., Ltd., London, Ont.
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Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

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Empire Mfg. Co., Ltd., London, Ont.

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International Chemical Co., Toronto, Ont
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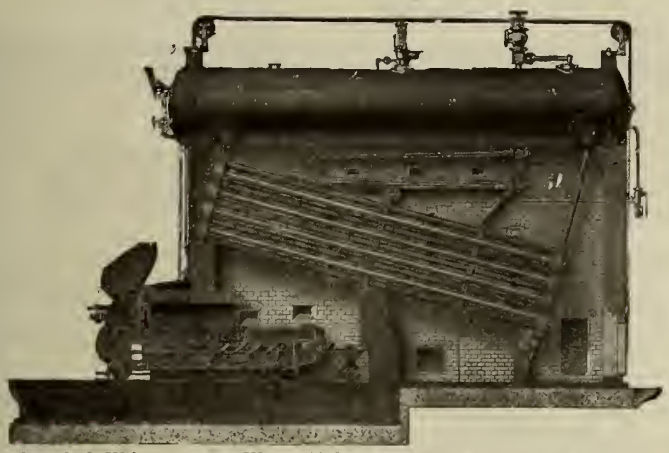

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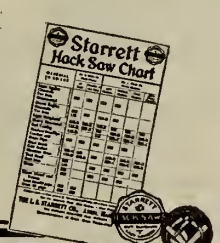

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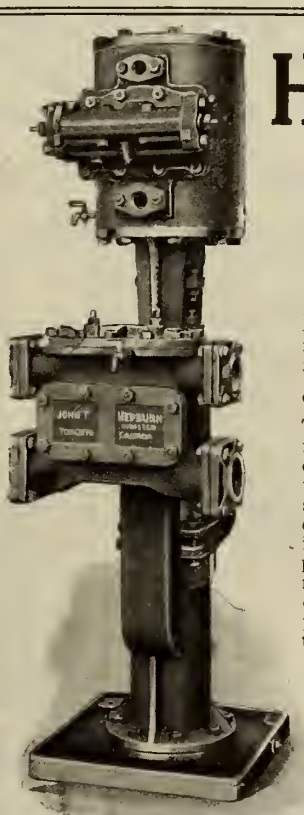

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Godfrey Conveyor Co., Toronto.
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Jeffrey Manufacturing Co., Montreal.
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MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Ministry of Munitions, London, England.
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
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Godfrey Conveyor Co., Elkhart, Ind.
Jeffrey Manufacturing Co., Montreal.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

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Jeffrey Manufacturing Co., Montreal.

COUPLING, FRICTION
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Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
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Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
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Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

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Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

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Can. Link-Belt Co., Toronto, Ont.
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CRANES, PORTABLE
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CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
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York Manufacturing Co., York, Pa.

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Jeffrey Mfg. Co., Montreal, Can.

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Holden Co., Limited, The, Montreal.

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Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
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ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

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Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

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Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

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Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

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Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
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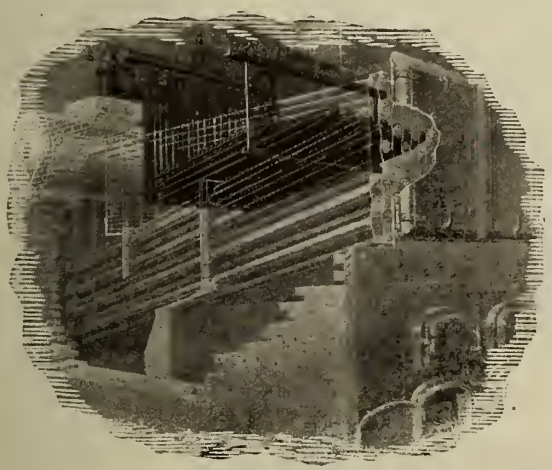

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Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co. Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
W. J. Brown (Tucks), Montreal.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

PACKING, ENGINE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Beldam Asbestos (Canada) Co., Toronto.
Gutta Percha & Rubber Ltd. Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Beldam Asbestos (Canada) Co., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Eqnipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
L'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

WEIR AUXILIARIES

Single Acting Simplex Feed Pumps
Turbine Rotary Feed Pumps
Compound Feed Pumps
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Direct Contact Heaters
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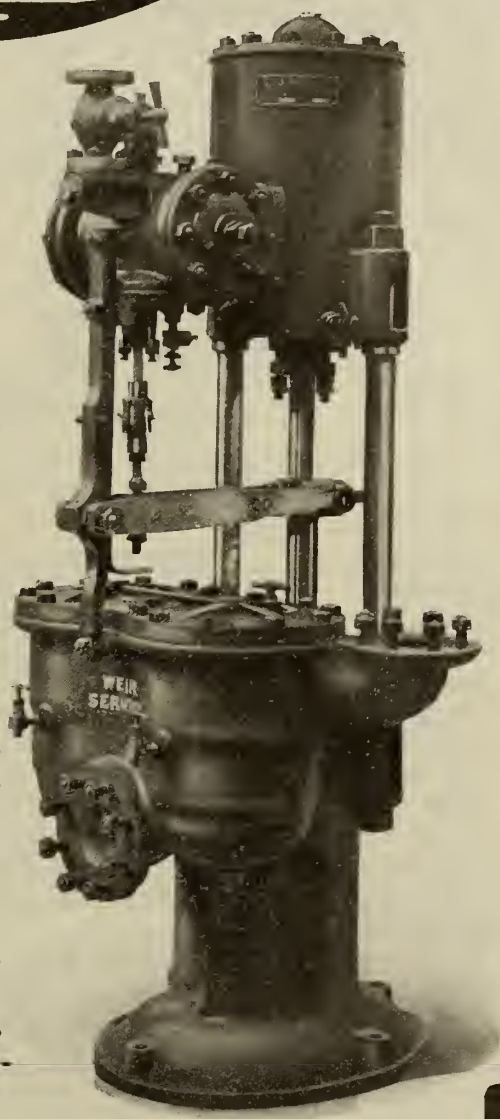

Single Payment Insurance

When insurance companies sell you an accident insurance policy they guarantee to make certain payments to you—but you have to be hurt to get them.

When you purchase Weir Power Plant Auxiliaries you have, by paying their initial cost, taken out a single payment insurance policy from which you benefit from the day of their installation.

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Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co. Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
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RADIATOR AIR VENTS
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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Hays Corp., Michigan City, Ind.

RECORDEDS CO2
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Sarco Company, Inc., New York.
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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

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McDonough, J., 323 Markham St., Toronto

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Paper Co., Ltd., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

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R. C. Miller Oil & Supply Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

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Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
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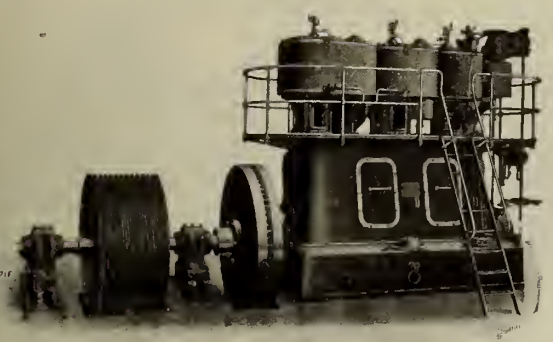

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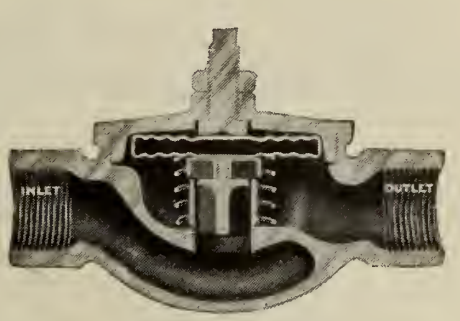

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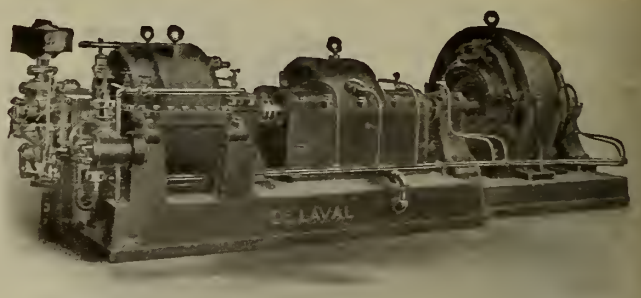

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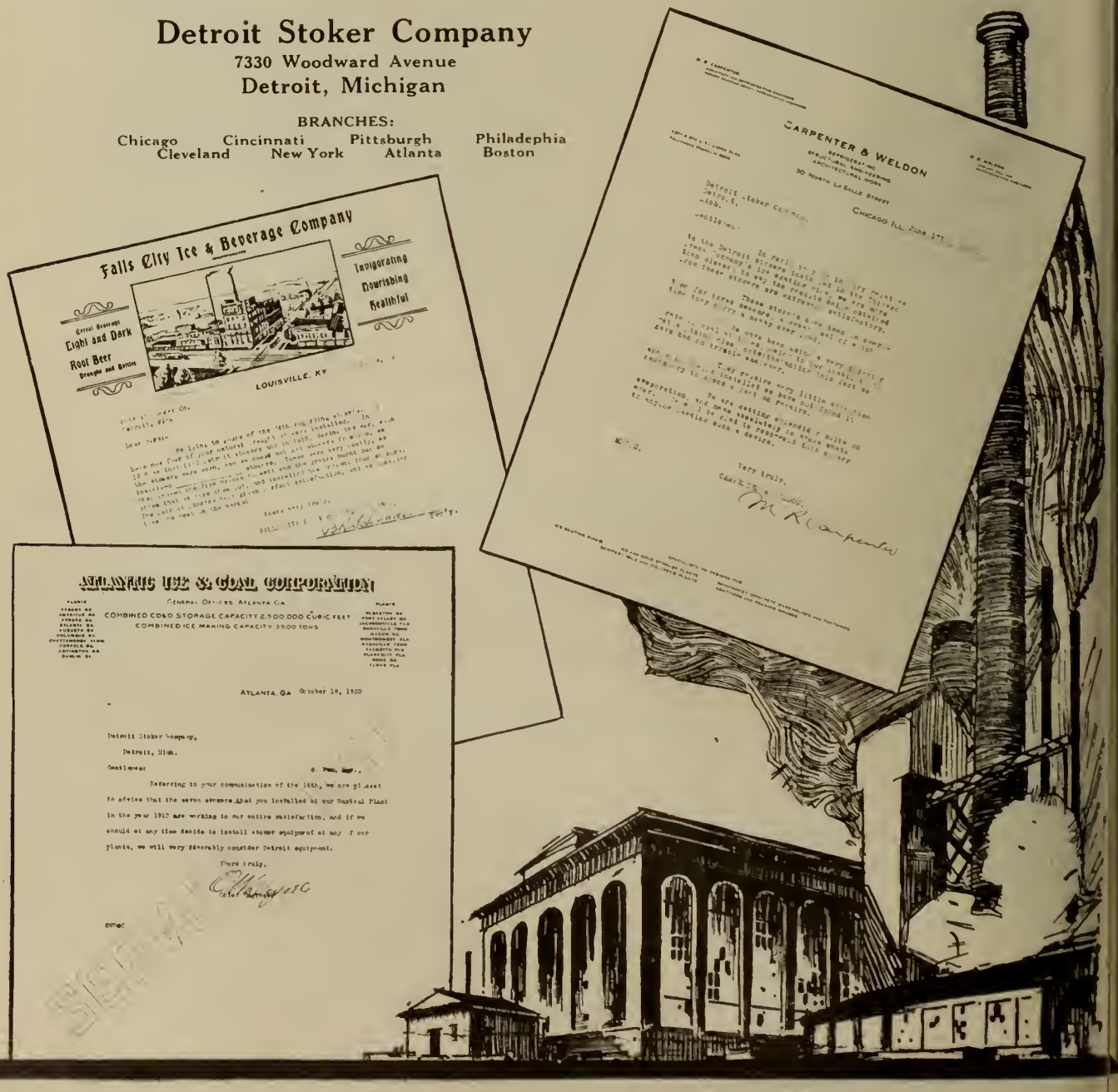
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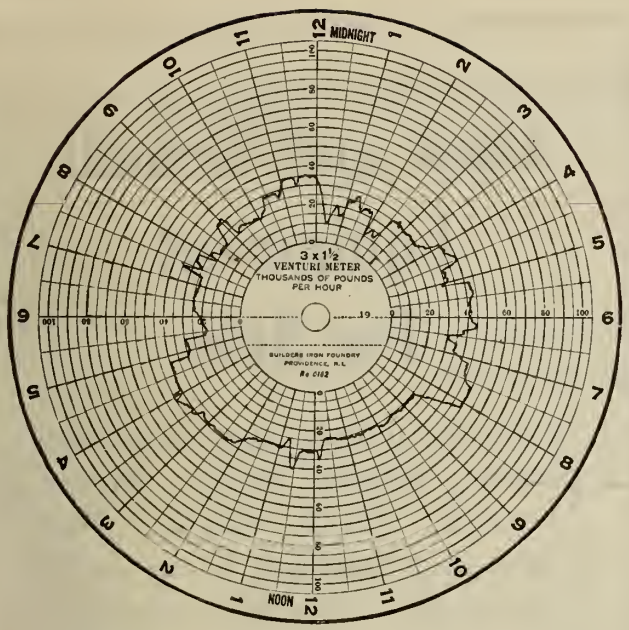
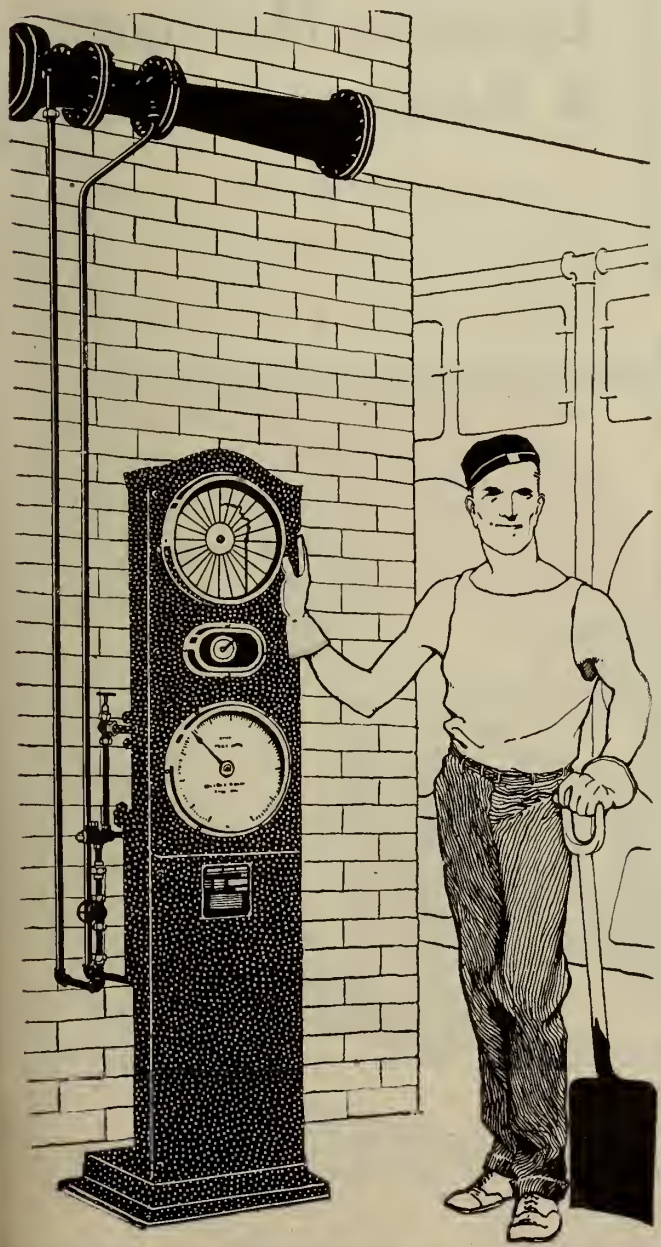
COMBINED ICE MAKING CAPACITY 3500 TONS
ATLANTA, GA October 18, 1920
Detroit Stoker Company,
Detroit, Mich.
Gentlemen:
Referring to your communication of the 14th, we are pleased to advise that the seven stokers that you installed in our Central Plant in the year 1912 are working to our entire satisfaction, and if we should at any time decide to install stoker equipment at any of our plants, we will very favorably consider Detroit equipment.
Yours truly,



This chart shows economical boiler feeding



FIRM FRIENDS

The Efficient Fireman and the Venturi Meter!

It is only the lazy and careless boiler tender who has no welcome for the Venturi, since it clearly reveals daily his wasteful methods.

The man who is alive to his employers' interest and who realizes that every possible B.t.u. must be squeezed out of the costly coal pile points with pride to the improvement he has made "since the Venturi was installed."

Bulletin No. 197, "Why Your Power Plant Needs a Venturi," is Ready.

Builders Iron Foundry

"Builders of the Venturi"

Providence, Rhode Island

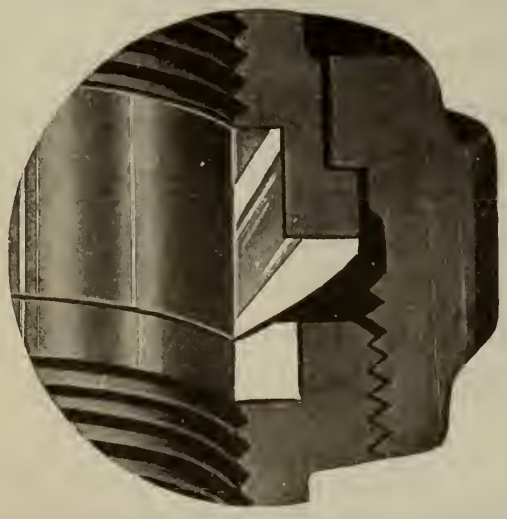
Canadian Representatives:

General Supply Co. of Canada, Ltd.
Ottawa Montreal Winnipeg Vancouver

Allen General Supplies, Limited
Toronto, Ontario

The Kind of Union That Never Leaks — They Just Can't

BRONZE to BRONZE AT THE JOINT



Note Enlarged View of "Dart" Ball-joint

Carefully note the enlarged view of a section of the "Dart" Bronze to Bronze joint, as well as the proportionately heavy malleable castings.

"Dart" Unions stay just as tight as you make them and will stand a greater strain than is usually required. These details have put "Dart" Unions into a class by themselves.

Manufactured and Guaranteed by

DART UNION COMPANY, LTD.

TORONTO, CANADA

Used and Rebuilt Equipment For Sale

If you are in the market for a Compressor, Engine Boiler, Motor, Dynamo, Drill, Lathe, Pipe Threading Machine, Hoist, etc., it will pay you to write for a copy of

Canadian Machinery & Manufacturing News

In addition to a Buyers' Directory of leading manufacturers of and dealers in New Machinery you will find lists of Used Equipment of almost every conceivable kind, and if you cannot find listed what you require drop us a line and we will locate it for you. This service is free to readers of POWER HOUSE. Just fill out the form below.

Canadian Machinery
& Manufacturing News
153 University Ave., Toronto, Ont.

Please send me a copy of CANADIAN MACHINERY & MANUFACTURING NEWS. I (or we) want to purchase the following equipment:

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(CANADIAN MACHINERY and POWER HOUSE are both published by The MacLean Publishing Co., Ltd., Toronto, Canada).

Less Wear and Tear

IMPERIAL Lubricants keep plant machinery running smoothly, reducing friction and consequent power loss.

Their regular use prolongs the life of your equipment, and increases its efficiency.

Imperial Lubricants are graded to meet the varied requirements of every type and make of machine. Each grade of oil is refined to the same exact, scientific standard. Ample supplies—every grade—carried in stock near you.

Many Imperial Oil customers voluntarily report savings as high as 35% in lubricating oil bills when following our recommendations. That's worth while economy that goes along with increased capacity and lowered depreciation costs.

Imperial Lubrication Engineers will gladly make it their business to see that you get full value from the lubricating oils you use. It will pay you to call in the Imperial Oil man and have him prescribe for your plant.

Write to 56 Church Street, Toronto, for more information.

Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO., Ltd. Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal

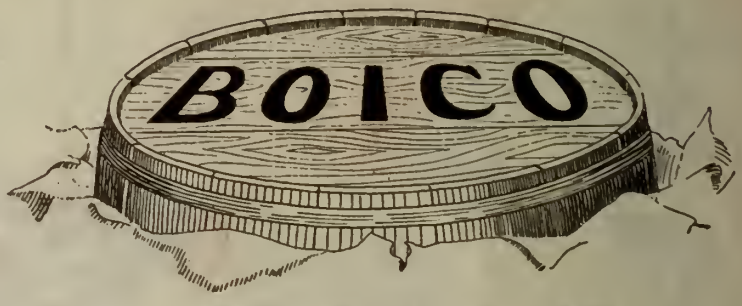
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

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Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.

"VULCABESTON" RED FIBRE STEAM SHEET PACKING

300 lb. Steam Pressure with 200° F. Superheat

An approximate temperature of 625° F., under the above conditions, is only a mild test for Vulcabeston Packing. It will stand much harder conditions easily.

In fact, whenever a gasket is needed for service of any character, it can be cut from

VULCABESTON
RED FIBRE SHEET PACKING

And a Vulcabeston gasket does not squeeze out, does not harden and lose its resiliency, does not disintegrate. Pressure, heat, moisture, acid and alkali have no effect.

Vulcabeston is "The Universal Packing"—it meets every need. "Specials" are entirely unnecessary when you use Vulcabeston.

The Johns-Pratt Company
Hartford, Conn. U. S. A.

Dealers in all large cities

20-12

VULCABESTON

A Size for Every Leak

YARWAY Pipe Clamps are made in all the usual pipe sizes from ½″ to 24″. They will stop most any leak, large or small, ammonia, steam, water or air—stop it completely and permanently. Can be applied by any workman in a very few minutes. The Yarway Pipe-Joint Clamp stops leaks at joints; the Yarway Holtite Pipe Clamp stops holes and splits in straight pipe. Cost is but a fraction of the expense of a neglected leak or what you would pay for taking down the line. Keep a supply on hand for emergencies.

25,000 Sold.

Yarnall-Waring Company

7604-20 Queen St., Chestnut Hill

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YARWAY

PIPE CLAMPS

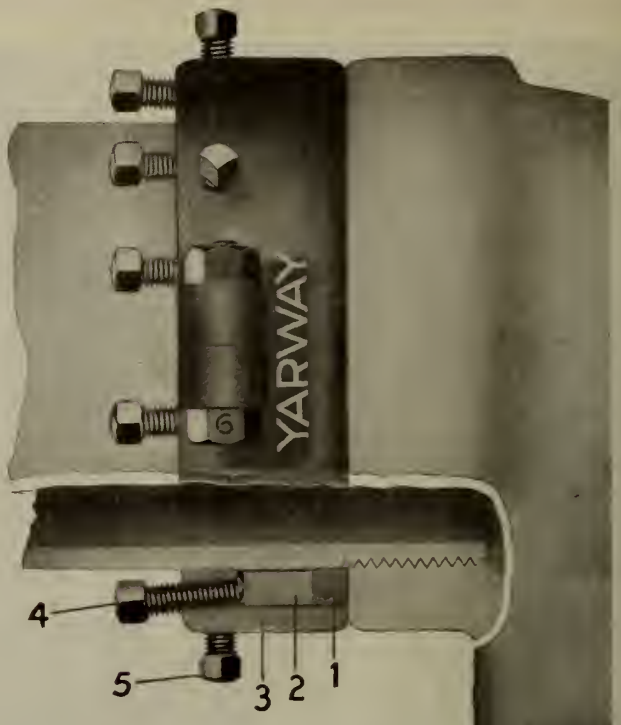
ALSO MAKERS OF

Yarway Seatless Blow-Off Valve
Yarway Double-Tightening Blow-Off Valve
Yarway Hydraulic Valve
Yarway Lea V-Notch Meter
Yarway Adjustable Spray Head
Yarway Unloader
Yarway Boiler Skimmer

Canadian Representatives:

Thompson & Gordon, West Hamilton, Ont.

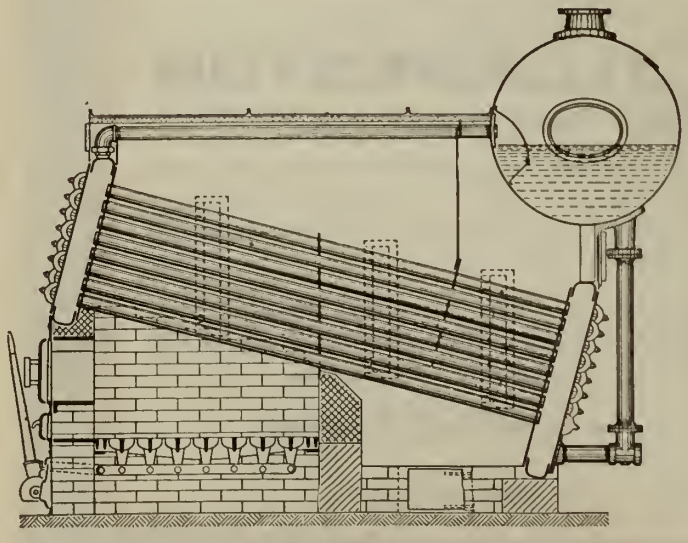
Send to-day for copy of booklet C-805, containing description, prices, etc., of Yarway Pipe-Joint Clamp and Yarway Holtite Pipe Clamp.



YARWAY PIPE JOINT CLAMP

Description—1. Square packing ring, forced against leaky joint. 2. Inside ring, forced against packing 1 by screws 4. 3. Outside ring, bolted around pipe by bolts 6, secured by set screws 5, prevents slipping when adjusting screws 4.

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N.S.

Montreal Office:
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Jenkins Valves

Made *for* Maximum Service

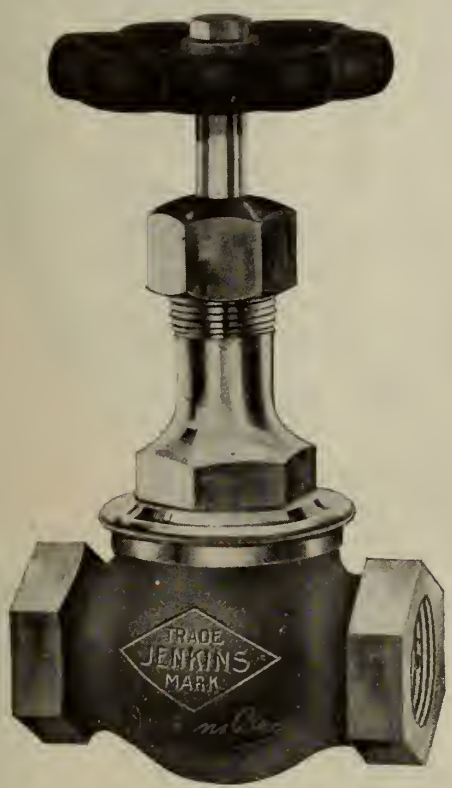

Fig. 106
JENKINS BRASS GLOBE VALVE
Suitable for 175 lbs. Working Steam Pressure or 250 lbs. Working Water Pressure.

The dependability and longevity of genuine Jenkins Valves are due to the fact that every valve in every type is made for the Maximum Service.

The man who knows valves and valve requirements installs Jenkins. Their trouble-free record in every branch of Service is a guarantee of satisfaction even under unusually severe conditions.

Jenkins Valves for every service are obtainable at supply houses everywhere. The line is very complete, including valves of brass, iron and cast steel for all requirements of power plants, industrial establishments, plumbing and heating service, etc. When buying look for the name "Jenkins" within a Diamond Mark on the body of the valve. It's there for your protection.

Catalog No. 8 describes the entire Jenkins line. Send for free copy.

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Stoker

Five Months o Steady Overload

Boilers in plant were l on line conti ously for months at 1 to 250% of ing. Name request.

Three Months Continuously—Peak Loads at 340%

Such is the operating record of this "A-C" equipped plant. Name furnished on request.

Three Months of Continuous High Capacity

Boilers were kept on line continuously for over three months. Loads varied from 75% of boiler rating to 250%. Name furnished if requested.

Service that Costs Less Per Year

Most plant owners and operators know that mechanical stokers are today a necessity from the standpoint of economy. Of course the stoker that gives lowest cost service is the stoker these power users want.

An investigation of the operating records of Jones equipped plants will convince them that Jones Stokers *do* give lowest cost service:

—that when the immense saving of these stokers is considered, first cost *is* lower.

—that because of their rugged simplicity—unequalled by any other multiple retort stoker—maintenance costs *are* lower.

—that their ability to meet high peak loads and heavy overloads, and maintain overloads constantly—confirmed by the plant records opposite—*does* mean still greater saving.

—that the saving of labor because of the ease of manipulation *is* greater.

—that the under-feed principle, as enhanced by improvements and refinements in Jones design, *does* mean greater economy in burning Canadian coals.

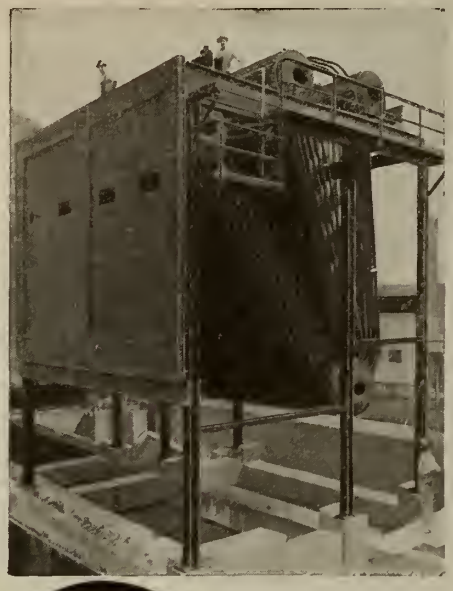
Jones Stokers are made in two types: Jones "A-C" (Automatic-cleaning) Stoker for highest-duty requirements, and Jones "Standard" Stokers for a wide range of service.

Jones engineers will investigate your plant conditions and advise the type best suited to your own plant conditions.

The Canadian Stoker
JONES STOKERS are made in Canada by Canadians and sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized, and the reorganization makes available for Canadian power users, the extensive engineering resources of the Under-Feed Stoker Co. of America.

The Under-Feed Stoker Co.
of Canada, Limited
81 VICTORIA STREET - - TORONTO

Jones Stokers



Connelly Water Tube Boilers (Patented U.S. & Canada)

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

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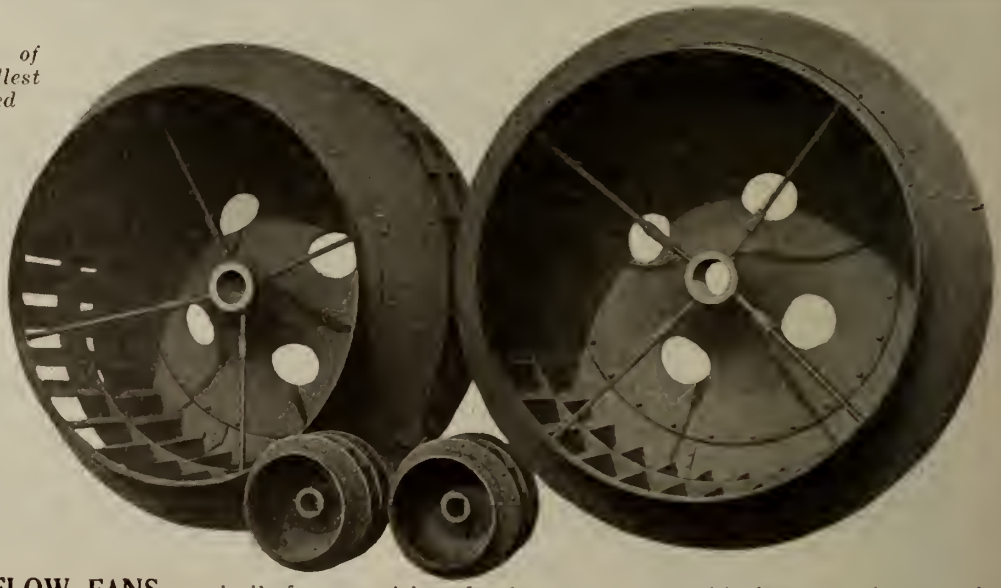
86th Year

LEONARD

Comparison in Size of the Largest and Smallest Fans Manufactured

More Draft for Less Power



GREEN'S RADIAL FLOW FANS are built for capacities of 1,600 to 275,000 cubic feet per minute and pressures up to 7 in. of water.

These fans, besides having low horsepower requirements, operate at the most economical speeds for direct connection to turbines and motors, making possible small high speed efficient units.

Fans are built in two types—"RB" and "RR"—for forced and induced draft, respectively.

Our Engineers will be glad to submit data covering the requirements of your individual draft problem. Let us send full details.

GREEN'S ECONOMISER, LIMITED.
TORONTO

Take a "Look-See"

as the Chinaman would say, into the heart of the boiler room, the furnace. If you find loose and broken bricks and crumbling mortar in the lining, there is the cause of heat loss and incomplete combustion.

PLIBRICO JOINTLESS

FURNACE LINING

will make any furnace absolutely air-tight and gas-tight. No joints where clinkers may stick, no mortar to fall out, no chance for heat loss that eats into your coal pile.

PLIBRICO is a high-grade refractory which comes in plastic form, easily installed. No skilled labor is needed. Ideal for baffle walls, side walls, front-door arches, and combustion-chamber arches.

Comes in steel containers of distinctive appearance as shown at the right. Warehouse stocks ready for delivery at Montreal, Toronto, Winnipeg, Vancouver and Calgary.

Send for interesting booklet L14 on Furnace Building.

JOINTLESS FIRE BRICK CO.
1142 Clay Street, Chicago, Ill.

AMONG a plumber's best friends are his tools and, among his tools, many a plumber claims Williams' "Vulcan" Drop-Forged Chain Pipe Vise as his best friend.

Ask for our "30 vs. 60 lbs." booklet. It will prove the value of "Vulcan" friendship.

J. H. WILLIAMS & CO.
LIMITED
"The Drop-Forging People"
FORMERLY CANADIAN DIVISION OF THE WHITMAN & BARNES MFG. CO.
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No Stoker is Better Than its GRATES

MURPHY AUTOMATIC FURNACES

Back of every feature of MURPHY GRATE construction are *many* sound reasons. Consider how these features save you dollars—in fuel—in labor—in maintenance.

The long—narrow—but deep sections give eighteen to twenty-eight square inches of cooling surface to every inch of exposed grate surface.

The liberal air space (47% to 52%) gives double the capacity of the boiler "without one penny for draft."

The correct proportion and distribution of ribs on the stationary grates, combined with the greatest accuracy of machine moulding have solved the sifting problem. The continuous movement of the ribless grates ¾" above and ¾" below the surface of the stationary grates—breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free—and advances the ash gradually to a point where it is removed by the clinker grinder. It is this action that gives the Murphy Furnace the faculty of ***burning anything that has heat in it.***

Yet with all these advantages, the Murphy Grate of to-day is built to the same policy that has characterized every improvement. First, to make all parts standard; second, to make every piece interchangeable; third, to advise users of new developments so that they may keep their equipment up-to-date—and operating at top-notch efficiency.

For information on the Riley Underfeed Stokers for large boilers, see February 5 advertisement or send for Riley Stoker catalog HR-4

MANUFACTURED EXCLUSIVELY BY

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

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York QUALITY Products and Expert ENGINEERING Advice are brought into close proximity to every user of Ice Making and Refrigerating Machinery by the York Service Organization.

The close, personal touch afforded by this organization in all our dealings with our customers, and the prompt service we are thereby enabled to render, has contributed in no small degree to the Confidence which the Trade places in York QUALITY Products.

Whether you are thinking of installing a new plant, require engineering advice, or need supplies for your Ice Making or Refrigerating Plant, it will pay you to write our nearest Branch.

MECHANICAL QUALITY YORK SERVICE **REFRIGERATION**

The Trade in the Dominion benefits by the ability and experience of this Organization through four regularly established Service Stations.

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Villiers & Munition Sts., Eastern Harbor Terminals

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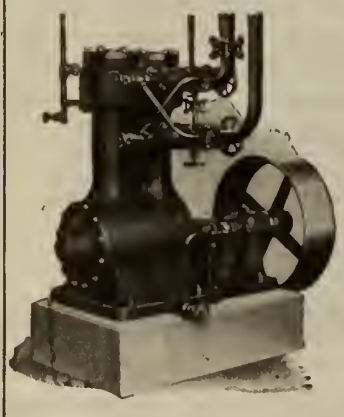
605 Second St.

YORK MANUFACTURING CO., YORK, PA., U.S.A.

(Ice Making and Refrigerating Machinery exclusively)



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

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242 Beecher St. - - - Milwaukee, Wisconsin

For Refrigerating Equipment

Use

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BUTTWELDED LAPWELDED

STEEL GENUINE WROUGHT IRON

PIPE

Special Redrawn Pipe for Ammonia Purposes

P H Continuous Coil recently manufactured

All Styles of Coils

PIPE BENDS FLANGED PIPE JOINTS

ALL KINDS AND SIZES

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114 Liberty Street - - - New York, N. Y.

SYNCHRONOUS MOTORS

1—150 H.P., 3 phase, 25 cycle, 2300/4000 volt, GENERAL ELECTRIC Synchronous Motor, 500 RPM. 22/38 amp., type ATI-6-125, form B, 6 poles. With pulley and base.

1—187½ KVA, 3 phase, 25 cycle, 2200 volt, GENERAL ELECTRIC Synchronous Motor, 390 RPM, type ATB-16, 102 amps., form E.

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1—435 KVA, 3 phase, 25 cycle, 2300 volt, GENERAL ELECTRIC Synchronous Motor, 750 RPM, type ATI. With Exciter and starting compensator.

1—985 H.P., 3 phase, 25 cycle, 2200 volt, GENERAL ELECTRIC Synchronous Motor, 136½ RPM, type ATI, 278 amps., 22 poles.

1—1075 K.W., 3 phase, 30 cycle, 6600 volt, WESTINGHOUSE Synchronous Motor, 450 RPM, 8 poles.

MACGOVERN & COMPANY, Inc.

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STRENGTH—GOODNESS—QUALITY

DURABLA Gaskets will give perfect service on ammonia joints in both absorption and compression systems regardless of the type of fitting.

The great value of DURABLA Gaskets in ice and refrigeration plant equipment lies in the fact that it can be used as a standard gasket on all joints giving equal satisfaction on any flange where a gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown due to gasket trouble.

Any amount of DURABLA Gasket Material, which is guaranteed to give perfect service in ammonia, air, oil, water, steam, gasoline and acid lines, will be sent on your written request to be paid for when found satisfactory.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

BOWSER

ESTABLISHED 1885

Oil Filtration Means Economy

Bowser Systems for filtering and serving lubricating oil to bearings are constructed to meet all practicable conditions in connection with engines and other machinery.

A Bowser System provides a stream of cool, clean oil continuously. It reduces the consumption of oils to a minimum by using over and over again. In fact, a change from hand feed lubricating methods to a Bowser System will result in a saving of from 50% to 90% in lubricating expense.

Write for our booklet on oil filtration.

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Branch Offices in Principal Cities of the World

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

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We have patent bending machines capable of bending steel tubing or pipe up to 6" by a cold process.

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Indicating, Recording, Controlling

A book that should have a place in every industrial library. Authoritative. 1,000 illustrations. Compiled by engineers. Serves also as catalogue for Tycos Temperature instruments.

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There's a Tycos or Taylor Temperature Instrument for every purpose

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

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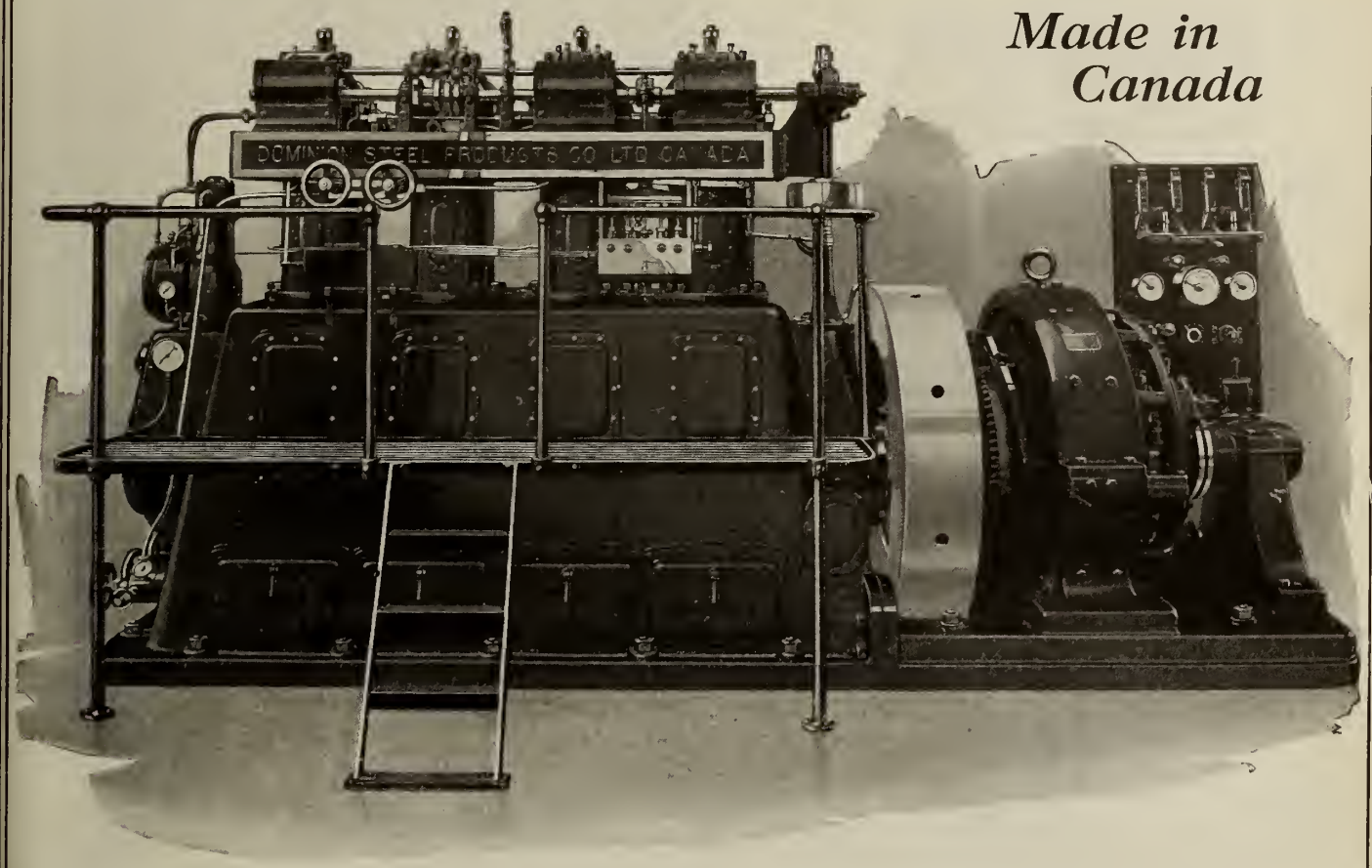
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



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D.S.P.—H.C. OIL ENGINE

For Central Service Station

THIS Made-in-Canada D.S.P.—H.C. Oil Engine is a four-cycle, single acting, heavy duty power unit, entirely self-contained and operates at high efficiency and constant speed under full or variable loads.

The unit consists of the engine, a two-stage air compressor, and container installed in the engine base for the storage of compressed air for fuel injection and engine starting.

D.S.P. Oil Engines are started cold within a few seconds and attain their rated capacity almost immediately. The operating cost stops when the engine is shut down, so there are no stand-by losses such as occur when fires are banked and attendance has to be maintained.

This is one of the most simple, durable and economical engines ever built and these claims are backed up by performance under actual working conditions of the most severe kind.

D.S.P. Oil Engines assure continuous and satisfactory service.

There are many interesting features which are fully illustrated in Bulletin No. 21. Write for it giving a general outline of your requirements.

DEPARTMENT O

DOMINION STEEL PRODUCTS CO., LIMITED

BRANTFORD, ONTARIO

The

REGISTERED COPPUS U.S.PAT. OFFICE

Turbo Blower
will give you
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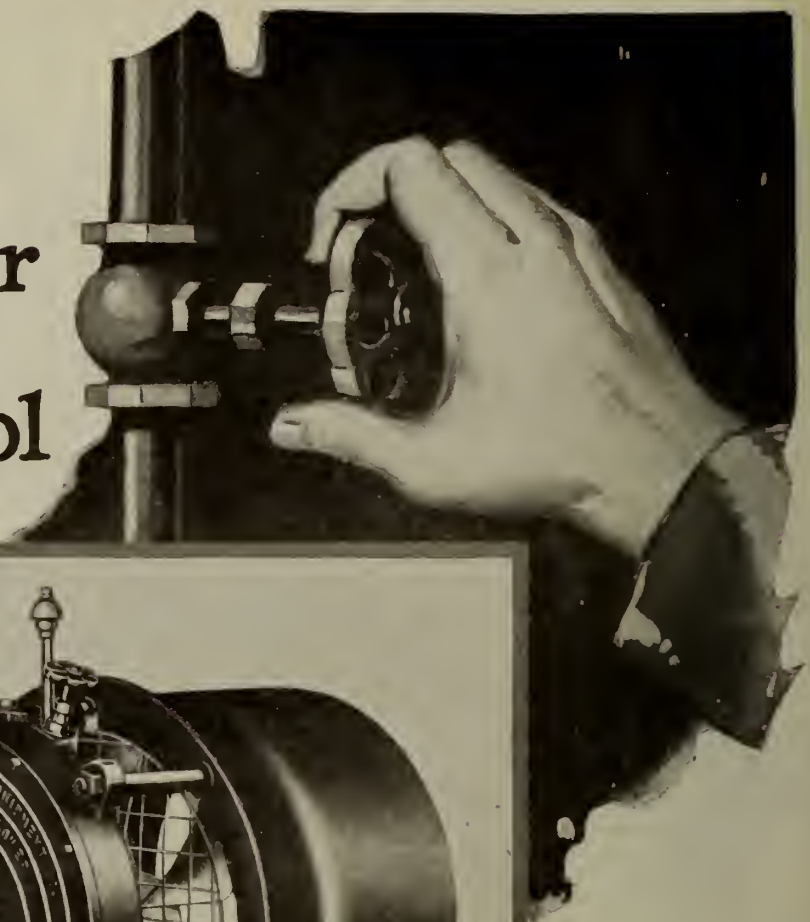

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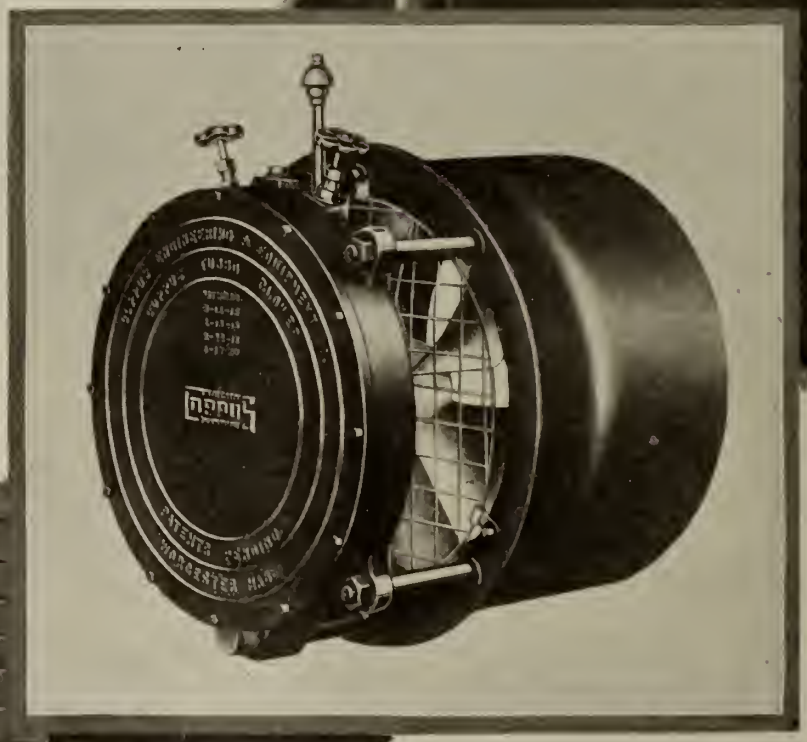

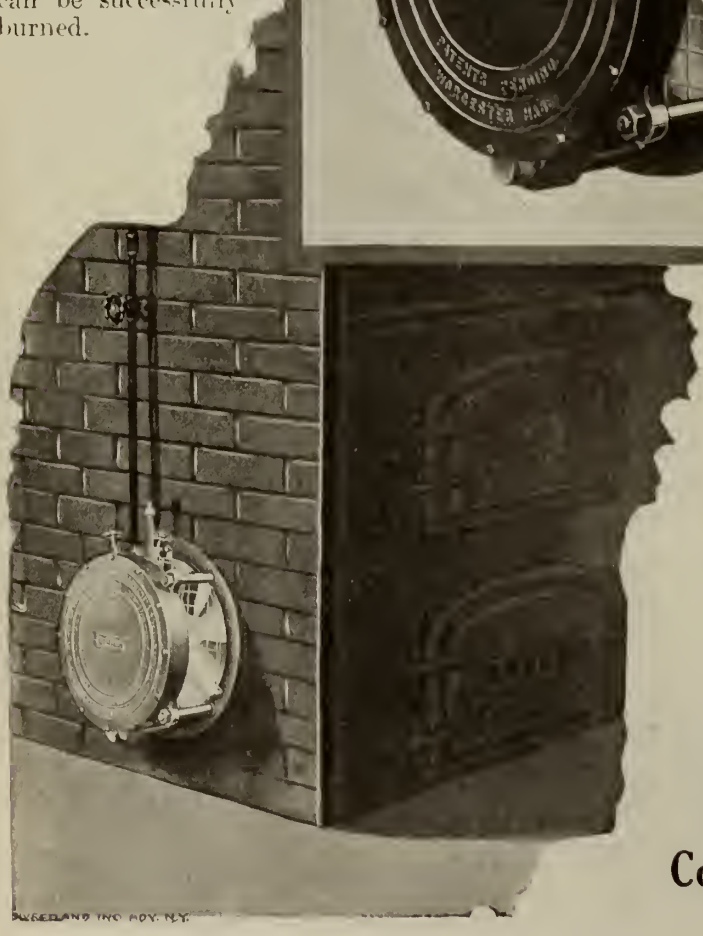

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Exterior view, Dominion Power and Transmission Co. Ltd., Hamilton, Ont., showing Two Kellogg Radial Brick Chimneys,— 240 ft. high, 12 ft. in diameter.

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The Power Plant Journal of Canada

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Producing Ice in an Up-To-Date Plant

The New Plant of the Lake Simcoe Ice Co. at George Street and Esplanade, Toronto—Output of Eighty Tons Per Day—Some Interesting Apparatus is in Use

By T. H. FENNER

WHEN the driver brings the 25 or 50 pound block of clear ice to the housewife's refrigerator, it is safe to say that she loses no time in thinking of the process that has delivered it to her. That process has been a very elaborate one, involving the use of expensive machinery and much thought on the part of designing and operating engineers. Refrigeration has become a very important part of our modern civilization, and that branch of it which is devoted to the making of ice very necessary to our comfort and health in the summer months. We had these thoughts in mind when we recently had the opportunity of inspecting the new ice-making plant of the Lake Simcoe Ice Co., Limited, at the foot of George Street.

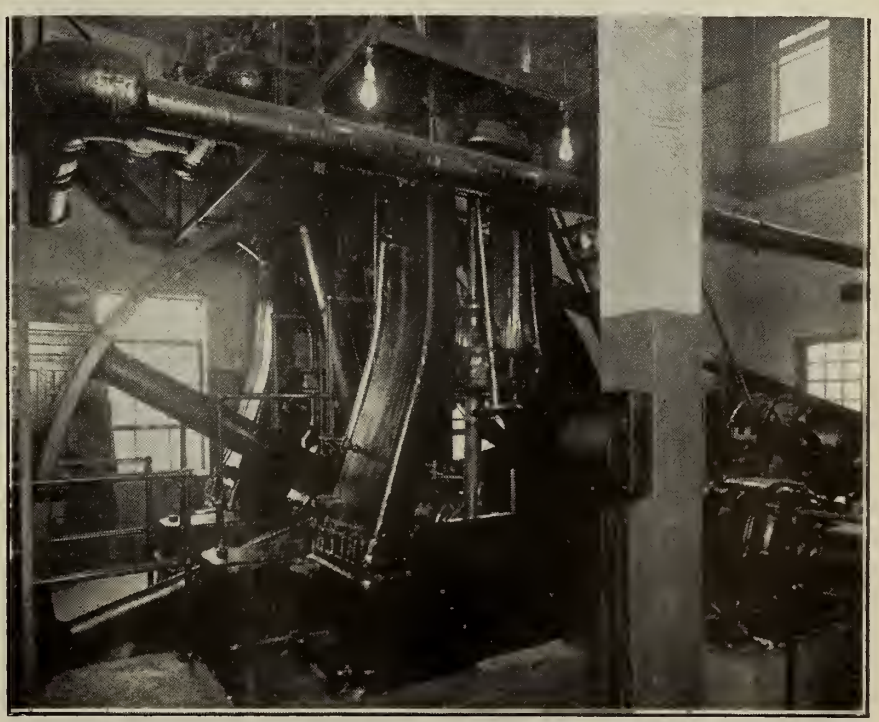
The George Street Plant

The plant which we are about to describe was erected last year, and started working in August. The machine was installed by the Canada Ice Machine Co., and is a twin compressor, made by the York Manufacturing Co., with fly wheel in the centre, motor driven, and rated at 57 tons ice making capacity. Most of our readers are aware that there is a distinction between ice making and refrigerating capacity, the refrigerating ton being based on the freezing of one ton of water into one ton of ice from and at 32 degrees F., in the twenty-four hours. The latent heat of ice being 144, this makes 288,000 B.t.u. per 24 hours. Ice making capacity is generally less than refrigerating capacity, in proportion to the difference in temperature between the water used and that of water at freezing temperature. Actually it runs from one-half to two-thirds the refrigerating capacity. This plant performs consistently better than its rating, the average daily output being between 79 and 80 tons of ice. The building contains the engine room, or we should say, compressor room, the ice making floor, a shipping room, and a 5,000 ton ice storage. The ice storage house is refrigerated with direct expansion coils, the same system being used in the shipping room storage. The ice making tank is refrigerated with both brine and direct expansion coils, the coils being placed between the container spaces in a stand ten pipes high.

The Compressor Room

The compressor room contains the main compressor, the auxiliary compressor, an air compressor, the brine tank, air storage tank, and the motors for driving the air and ammonia compressors. The liquid receiver from the ammonia condensor is also situated in the compressor room, and the expansion valves to the various refrigerating coils are also situated here, so that the man in charge has everything under control with a minimum of movement. The gauge board is set on the wall at the right hand side of the compressor room in such a position that it can be read from almost any point in the room. The motor driving the main compressor is a 200 H.P., 3 phase, 480 R.P.M. induction motor, made by the Canadian Westinghouse, and drives through a belt to the flywheel of the compressor. The bearing lubrication on the compressor is looked after by a small geared pump, which elevates the oil from the crank pits to a tank fixed on the top platform, and after filtering it runs to the various bearings by gravity. Telescopic oil pipes are used on the crosshead and crankpins. The compressor glands are fitted with universal tightening gear, operated through a rack and pinions on each gland, the pinion shaft being brought down the side of the column to a hand wheel in easy reach of the operator.

During the winter the main machine takes care of the ice making and cold storage, but in the summer months the small machine is put on the storage space and the main machine is kept strictly for ice making. The ice making goes on night and day all the year round, except-



THE 57-TON ICE-MAKING CAPACITY COMPRESSOR.

ing for a short stop for overhauling during the winter.

The pressures carried are the usual ones, the suction side carrying about 10 to 15 pounds per square inch, while the condensor side runs at from 165 to 180 pounds per square inch. The higher pressures will depend on the temperature of the condensing water, and the actual condition of the condensor itself.

The ammonia from the discharge of high pressure side of the ammonia compressor goes through a double pipe condensor situated on the same floor as the ice making room, which can be seen plainly in the illustration. The condensate passes to the liquid receiver in the engine room, which is situated directly below the condensor, and thence to the brine tank, the ice making tanks, and the direct expansion coils in the storage and shipping rooms. The ammonia after being boiled and extracting heat from the brine and storage rooms, is brought back to a common suction receiver and then drawn into the compressor to resume its cycle.

This part of the plant is the usual type of refrigerating apparatus. It is when we come to the actual ice making part of the plant, which the refrigerating machine serves, that the interesting features are found.

VIEW OF DOUBLE PIPE CONDENSOR.

The Ice Making Room

The ice making room is shown in our illustration, and this is, of course, the main part of the plant. The illustration gives a clear idea of the layout, and we can consider the process in detail with the assistance of the detailed illustrations shown.

The water comes into the plant through filters filled with charcoal and sand, which effectually remove any impurities which may have got into it in its passage through the city mains. After passing through these filters it goes into a larger tank, which serves a double purpose. It is of large enough capacity to act as a settling basin, and besides that a coil is taken from the ammonia pipe on its way back to the suction side of the compressor, and passes through the tank, thus acting as a forecooler to reduce the water temperature before it goes into the cans. The ice making tank has a capacity of 572 cans, each of which contains 400 lbs. of ice after being frozen. The containers, or cans, which are to be plainly seen in the illustrations, are handled in pairs, and the amount of time allowed for freezing is about thirty-five and a half hours. The freezing is accomplished by lowering the containers into a bath of brine, through which the direct expansion coils are laid, and which is kept continually agitated by two motor-driven agitators at one end of the tank, besides the circulation due to the pump. The city water after filtering and forecooling is piped off to two rubber hose pipes, at the end of each being the automatic filling arrangement. This can be seen in the illustration, and consists of a brass stand for holding the pipe, and a delivery nozzle, to which is attached a trigger operated valve and a ball float. The filling of the containers is accomplished by putting the delivery pipe into the container, where it is held by the brass stand. It is allowed to go into the container just so far, that when the water is at the desired height the water will operate a float attached to the delivery pipe. This float lifts with the action of the water, and kicks off the trigger of the valve, which immediately closes. The containers, when first dropped into the brine, are, of course, buoyant, but they sink as the water gradually fills them, until when they are filled they are down in the brine to their full length. The brine in the freezing tank is kept at a temperature of about 10 degrees above zero, and the freezing process starts immediately the containers are put in.

THE ICE MAKING FLOOR.

In order that the ice shall be clear, and free from cloudiness, it is necessary to keep the water in the containers agitated during the whole time that they are being frozen. In order to do this, a jet of compressed air is delivered to each can at a pressure of about 18 to 20 lbs. per square inch. As the water freezes, it expels all impurities, and as it freezes from the edges of the can towards the

THE HOIST IS READY TO LIFT TWO FROZEN CANS, TWO EMPTIES HAVE JUST BEEN DEPOSITED, AND ON THE RIGHT TWO CANS ARE JUST FILLED.

centre, these impurities are forced into a very narrow space in the centre of the block of ice, and thence forced upwards towards the open end at the top of the container. Thus there is left a small cavity or pipe at the top of the block, much like the pipe in the top of an ingot of steel, and as in the ingot, containing all the impurities, which can be cut off. The path of escape of the imprisoned air and any impurities that may be present can be traced in the otherwise clear block of ice by a very narrow fin that starts near the bottom of the block and reaches right up to the bottom of the cavity just mentioned.

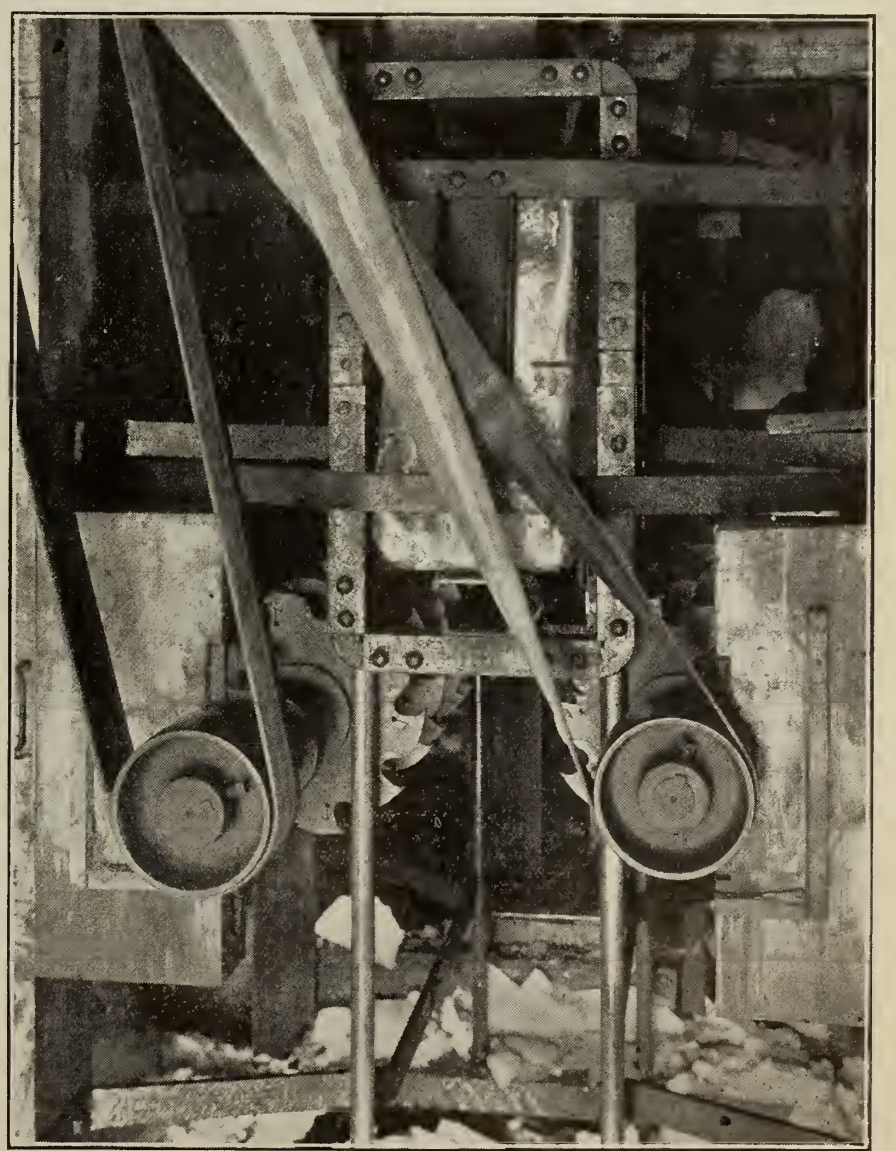
The air that is used for agitating the water in the containers is supplied by the air compressor, as previously stated. This air is also cooled before being delivered to the containers by being passed through the brine tank by means of a coil. The air compressor delivers to a large storage tank in the compressor room, and the discharge from this tank is piped up to the brine tank. The air storage tank is large enough to ensure a supply of air for an hour if by any chance the power should go off, or it should be necessary to close off the compressor for any reason.

The Operating Routine

Having seen how the freezing of the water is accomplished, and the methods employed to obtain clear ice, we may now look into the production part of the business, which is a very important feature from the commercial standpoint, as well as from the engineering view.

We have seen that the total capacity of the ice making room is 572 cans of 400 lbs. each. The actual number of cans pulled per day is 396, and the system employed is about as follows: The time allowed for freezing is just about one day and a half, so that a container filled at midnight one day would be pulled out at noon on the second day following. The men on the floor pull the frozen cans out in pairs, by means of the traveling electric hoist seen in the picture, and carry them over to one side of the room, where they are left to stand till their temperature has risen from that of the brine tank to about freezing point.

There are a number of full cans always standing on the floor, going through this process of tempering as it is called, and after the hoist man has deposited the two latest, he takes his hoist along to two other cans, which have been pulled earlier, and are now at about the temperature of freezing, or a little below it. He takes these two cans and lowers them into a sump, or hot water tank, the effect of which is to loosen the block of ice from the sides of the container. This process is little more than a dipping, and the containers are now lifted out again, and taken to the swinging carriage, which can be seen in the general illustration of the ice making room. This carriage is then swung over and the block of ice slides out, and is directed by means of a wooden guide



SAWS FOR NICKING ICE BLOCKS.

TURNING OUT THE BLOCK FOR CONTAINER.

or valve, to one side or other of a hoist, or gig, which operates automatically.

Meanwhile, the man on the floor has not been idle. Looking at the illustration one may notice that the hoist man has coupled on to two full cans, while he has just deposited two empty cans, and there are still two others which are being filled and are just about up to their level. In this way these two men handle about eighteen cans per hour. The time allowed for tempering is about two hours, which means that there must always be a supply of cans ahead of the men.

When the block of ice is shot out of the container it is guided to the hoist, which has two compartments. These two compartments lead, when the hoist arrives at the lower floor, to two passages, which the ice descends by gravity. One of these leads to the shipping room and the other to an arrangement of saws.

The hoist itself is absolutely automatic. It consists of three parts, the ice carriage, a counterweight, and an air cylinder with a double piston. The counterweight is heavy enough to overbalance the gig or hoist when it is empty, but not when there is a block of ice upon it. The hoist is attached by a cable to the piston rod of the air cylinder. This has a valve at the top and one at the bottom, and the piston is made with a double leather washer. The action is that when a block of ice is put on the hoist, it overbalances the counterweight, and the hoist goes down. In order that it shall not go too quickly, it has to pull the piston of the air cylinder up against the air in the cylinder, and the speed at which this can escape is regulated by the opening of the valve on the cylinder end. The same method applies in the reverse direction when the ice is taken off at the bottom of the hoist. The counterweight then pulls the hoist up, and in order that it does not go too quickly, it is checked by the opposite side of the piston.

When the ice arrives at the bottom of the hoist, it may go to the storage or to the saw. If it is to be supplied for car refrigerating or cold storage, such as butchers, it goes to the storage just as it is. If it is to be supplied to the drivers for the household trade it goes to the saws. These saws nick the block in a horizontal direction, through the centre, while at the same time nicking it on the side vertically. The result is to divide the block exactly into eight twenty-five pound blocks, which, while all contained in one, only require a prod from the driver's pick to break off into exactly weighed pieces of twenty-five, fifty, or seventy-five, or whatever the case may be. This does away with the use of scales, the necessity for chopping and wastage resulting, and also the possibility of dispute. Our photograph shows the saws with a block of ice in place.

The last photograph shows the ice being shipped on to the delivery wagon and it can be seen how clear it is.

The plant is modern in every way, and the results obtained are certainly satisfactory. From a production standpoint with a minimum of labor it commends itself highly to the observer. One pleasing feature of the plant was the absolute cleanliness observed throughout. It was also good to note that real good accommodation for washing, etc., had been provided for the men employed about the plant.

We wish to express our appreciation of the courtesy of Mr. Newnham Fairhead, the company's chief engineer, who personally explained the leading features of the plant on the occasion of our visit.

THE FINISHED PRODUCT.

TECHNICAL PAPER

The United States Bureau of Mines announces the issuance of Technical Paper 254, "The analysis of sulphur forms in coal," by Alfred R. Powell, organic chemist.

This paper describes and elaborates the method for the determination of the various forms of sulphur in coal as originally outlined by the author while working with Prof. S. W. Parr at the University of Illinois. The method, which at that time was found to be applicable to Illinois coals, is shown by the results of the present investigation to be accurate when applied to coals from widely different fields. Certain changes and optional methods of procedure are suggested which it is hoped will make the method conform better to routine and rapid commercial analysis.

Copies of Technical Paper 254 may be obtained by applying to the Director of the Bureau of Mines, Washington, D.C.

Mechanical Stokers in Refigerating Plants

Advantages of Mechanical Stokers—A Canadian Example—Standardized Firing Practice—Some Results of Stoker Tests—Some Details in the Handling of Stokers.

By ROBERT JUNE

POWER is one of the largest items of expense in most manufacturing businesses, and the cost of fuel represents on the average 70 per cent. of the cost of power. And the cost of fuel is going up. Nothing short of the discovery of a new source of power can stop the rising tendency of coal prices.

Since waste in the coal pile represents dollars which should be conserved for the dividend pile, it stands the power plant operator in hand to use the most economical grade of fuel.

The first point to bear in mind is that the most economical grade of fuel varies with different furnaces and methods of combustion. As an illustration: Coal selling at a very low price per ton may be more expensive to burn than a better grade of coal under certain furnace conditions. When these conditions are changed it may be found that a cheaper grade of coal is the most economical and that an appreciable saving in operating costs has been effected through the improvement in methods of firing.

The furnace is often the weakest link in the chain of economical steam production. The amount of coal burned to produce the results demanded is often far in excess of what would be required by careful, intelligent management. In many cases existing plants have been redesigned for a cheaper grade of fuel, and it is to-day becoming quite a frequent practice to design boiler furnaces, especially to permit the use of a low grade of fuel.

One of the conditions necessary to the efficient, and in particular the smokeless combustion of coal, is uniform liberation of the volatile gases. This is a condition which practically never can be realized in the hand-fired furnace. Inasmuch as the hand-fired furnace also presents pretty definite limitations in the way of utilizing the cheapest grades of fuel, we find that the way to improve boiler-room operating conditions is to install mechanical stokers.

Advantages of Mechanical Stokers

Among the advantages attaching to the use of mechanical stokers are the following:

A.—Hand firing is intermittent and its evenness and effectiveness depend on the individual skill of the fireman and the degree of attention which he accords his work. With the automatic stoker firing is continuous and uniformly even.

B.—Cleaning of fires in hand-fired furnaces is also intermittent and often erratic and is dependent solely upon the skill of the fireman. With stokers the fires are automatically and continuously cleaned, thus insuring increased efficiency in combustion.

C.—With hand-firing there is a constant opening of doors, thus admitting large quantities of cold air into the furnace. The depth of the fuel bed is also a variable factor and the amount of air that comes up through the fuel bed accordingly varies from one time to another. With stokers, on the other hand, it is possible to secure practically constant and uniform supply of air which can be controlled to agree with operating conditions.

D.—With hand-firing, one fireman can at the best take care of from 250 to 500 h.p. of boilers, whereas with automatic stokers one fireman can take care of 2,000 to 3,000 h.p. of boilers, hence the stokers reduce this item of labor cost 75 per cent. or more.

E.—One of the outstanding advantages of automatic stokers is their ability to burn efficiently cheaper grades of fuel than can be burned to advantage with hand-firing. The importance of this factor can readily be estimated as a saving in this direction alone may amount to enough to pay for the stoker installation several times over in the course of a year.

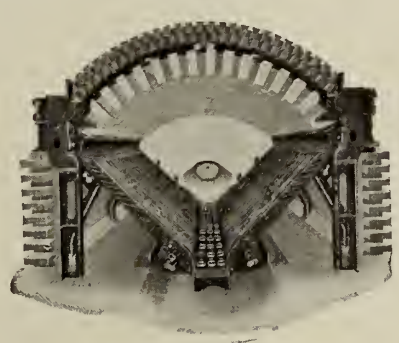


FIG. 1.—REAR VIEW OF STOKER. RADIAL ARCH.

F.—With hand-firing it is next to impossible to prevent the discharge of large amounts of smoke from the stack. This is due to the intermittent character of the firing and the lack of uniformity in the liberation of the volatile gases. With the stoker the smoke nuisance is to an appreciable extent within control.

The Case of a Canadian Refrigerating Plant

The writer's attention has recently been called to two Canadian refrigerating plants of approximately equal capacity. One of these plants had hand-fired furnaces, and further, the bad conditions of this type of firing had a psychological effect on those working in the boiler room. The place was in a generally ill-kept and unsatisfactory condition. The other plant was equipped with mechanical stokers of the side-feed V-type, and perhaps because the attainment of efficiency in combustion stimulated the firemen to better work all around, the boiler room was in first-class condition. The first plant was using half again as much coal as the second, and because of the very bad features of boiler-room operation the cost of steam generation was actually twice the cost of generation in the second plant.

A study of the psychology of the fireman who labors under adverse conditions is replete with interest. Too often he works in a dimly lighted boiler-room and with equipment so inefficient that any incentive he may have toward improving conditions becomes buried. Where careless management prevails, coal soon comes to mean to him nothing but a black substance of unlimited supply. When the storage space gets empty, coal cars or motor trucks refill it. The boss who pays for it makes no demands regarding the saving of fuel. The management's one demand is that steam should be kept up, and therefore why should he, the fireman, who shovels coal hour after hour and day after day be concerned with anything but the pressure gauge?

This was the condition existing in the first boiler-room. When the management finally took up the problem of reducing the cost of steam generation they found the firemen ready and willing to cooperate. When it was proposed to install stokers the management found the men actually welcoming the idea, although they realized that some changes would have to be made in the number of men working in the boiler-room. For this

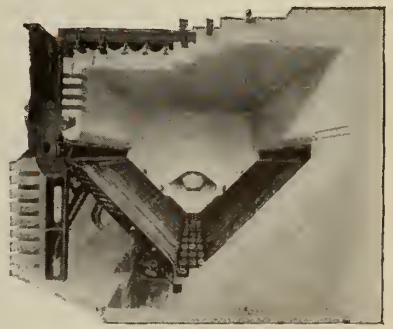


FIG. 2—REAR VIEW WITH FLAT SUSPENDED ARCH.

particular plant the type of mechanical stoker chosen was one which would operate economically with the natural draft, without an auxiliary fan or blower. After the installation had been completed it was found that a cheaper grade of fuel than had previously been used could be burned, and that due to the uniformity with which the stoker fed the fuel, the proper proportion of air in combustion, the absence of large amounts of excess air, the self-cleaning feature of the grates, etc., that it was possible to maintain a uniform boiler efficiency of approximately 70 per cent., whereas 55 per cent. had been the rule before, and that the same amount of steam could be generated with considerably less coal.

With the installation of the stokers a transformation took place in the boiler room. The firemen began to display a hearty interest in their work, with the result that the esprit de corps of the operators and the whole appearance of the boiler-room was changed. As a result, the cost of producing steam in this plant was reduced something like 50 per cent., bringing it down to the cost in the second plant. There has been no difficulty in maintaining costs at this low figure.

Standardized Firing Practice

Daily records are essential with any method of firing if economy is an object. These reduce to the low-limit the human element. From them is derived the proper adjustment of air supply, rate of feed, and depth of fire. It should be the aim of the operating engineer to standardize his firing practice.

When a condition of smokelessness of stacks is desirable by reason of local smoke-regulating ordinances, or because of its injury to the manufactured product (as in paper mills), the fact is that the best results can be obtained by the use of mechanical stokers. And the reason for this is that, as compared with hand-firing, there is a much longer time for combustion. As the volatile gases are distilled they are acted upon by ignition arches prior to coming in contact with the cooler heating surfaces. Otherwise they would fail of ignition and pass out of the stack unconsumed. Where space permits stokers may be installed so as to extend beyond the boiler front. This gives an added length of travel during which the gases are acted upon by the radiant heat from the ignition or supplementary arches, and are properly consumed.

Stokers, as has been stated, often reduce labor costs 50 to 75 per cent., or more. The slow-running, self-cleaning types require much less attention than hand-fired furnaces.

For boilers operating up to 200 per cent. rating the side-feed, V-type stoker, such as the type illustrated herewith, makes a desirable and economical installation. It possesses a much larger coking area than the other types of stokers. As the combustion area is likewise very large, it is possible to secure complete and practically smokeless operation. It operates with natural draft.

FIG. 4.—AFTER STOKER INSTALLATION.

Two magaines located on each side of the stoker supply the coal. Coking plates are inclined at a steep slope toward the center of the furnace. As the coal leaves the magazines it rests for a short time upon the coking plates. During this period the volatile gases are driven off and mixed with air which has been pre-heated by admission through the arch over the fire.

Gravity plays an important part in the operation of this type, and little power is required to actuate clinker crusher and oscillate grates. The fuel travels slowly from the inclined grates toward the clinker grinder, receiving the requisite amount of air through the grates to complete the process of combustion. By the time the lower portion of the grate is reached the combustion is completed, and ash and clinker are removed automatically. Maintenance cost is low, due to the small number of parts coming in contact with the fire.

Stoker boxes push the coal into the grates. The speed of this operation is easily regulated. As combustion proceeds the grates oscillate and have a slicing effect on the fuel. This permits free admission of the air and assures complete combustion. In stokers of this type the clinker grinders can be adjusted to operate independently of the remainder of the mechanism. If the coal contains a large amount of ash and clinker the grinder may be adjusted to operate faster to remove them. At the same time the coal may be fed at a slow rate if desired.

Results of Stoker Tests

The savings in coal effected by the use of mechanical stokers are very large. This result is to be expected in view of the fact that stokers increase the overall boiler efficiency from the general average of 55 per cent. for hand-fired furnaces to a general average of 70 per cent. for stoker-fired. As indicative of the high boiler efficiencies readily obtained from the use of

FIG. 5.—BEFORE STOKER INSTALLATION.

mechanical stokers we include Table 1, which shows results of a test at normal rating on Detroit stokers at the well-known American refrigerating plant of the Merchant's Ice & Cold Storage Co., Louisville, Ky.

A number of Canadian refrigerating plants are equipped with this type of stoker and outside of the refrigerating industry they are to be found in many other lines.

TABLE 1.

MERCHANTS ICE & COLD STORAGE CO.,
Plant No. 3 7th and Grayson. Louisville, Ky.
Test on one Detroit "V" Type Stoker.
Under One H.R.T. Boiler—66" x 18' 0" (Vogt).

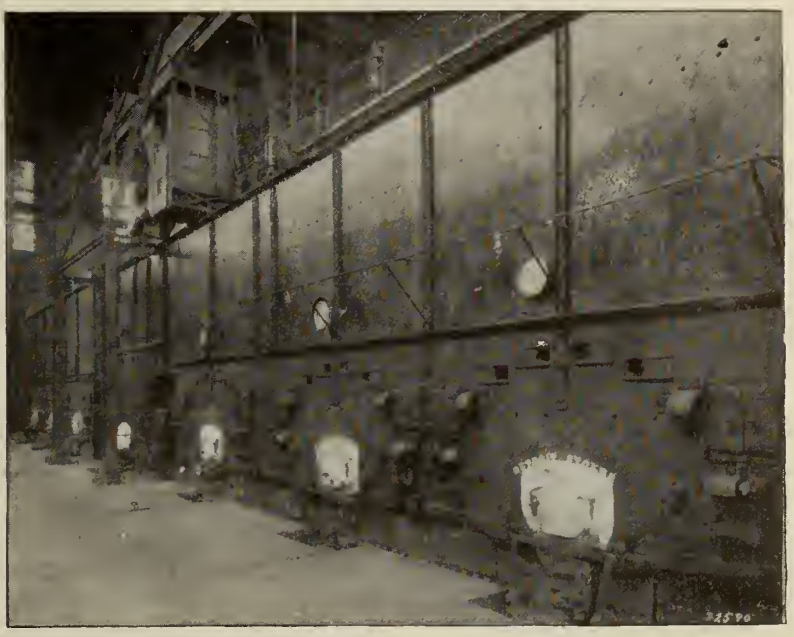
H.P. of boiler (owner's rating)	120 H.P.
Size of Stoker	4' 11" x 5' 3"
Grate surface	27 sq. ft. projected
Duration of trial	8 hours
Kind of fuel	Kenawa Gas Coal Slack
Total Quantities	
1. Duration of trial	8 hours
2. Weight of coal as fired	3,576 lbs.
3. Per cent. of moisture in coal	5.38%
4. Total weight of dry coal fired	3,384 lbs.
5. Total ash and refuse	463 lbs.
6. Per cent. of ash and refuse in dry coal	13.7%
7. Total weight of water feed to boiler	32,508 lbs.
8. Factor of evaporation	1.083
9. Equivalent water fed to boiler from and at 212°	35,206 lbs.
Hourly Quantities	
10. Dry coal fired per hour	423 lbs.
11. Dry coal per sq. ft. of grate per hour	15.66 lbs.
12. Water evaporated per hour	4063.5 lbs.
13. Equivalent water per hour from and at 212 deg.	4400.7 lbs.
Averages—Pres. and Temp.	
14. Steam pressure by gauge	99.6 lbs.
15. Temperature of feed water	170.3° F.
16. Temperature of flue gas	507° F.
17. Force of draft in breeching	.....
18. Force of draft over fire	.10"
Horse Power.	
19. Horse power developed	127.5
20. Builders' rated horse power	120
21. Per cent. of builders' rating developed	*106.3%
Economic Results	
22. Water evaporated per pound of coal as fired	9.09 lbs.
23. Equivalent evaporation from and at 212° per pound of coal as fired	9.84 lbs.
24. Equivalent evaporation from and at 212° per pound of dry coal.	10.40 lbs.
25. Equivalent evaporation from and at 212° per lb. of combustible.	12.05 lbs.
Coal Analysis	
Moisture	5.38%
Volatile carbon	.....
Fixed carbon	.....
Ash	10.0%
B.T.U. of coal as fired	13,088
B.Y.U. per pound of dry coal	13,833
Efficiency.	
Efficiency of boiler, including stoker, based on dry coal	72.6%

*Note.—Test purposely run at normal rating of boiler.

Details to be Remembered in Handling Stokers

Mechanical stokers are a good paying investment and they are badly needed in large numbers of plants where they are not now used. Do not think because you operate a small boiler that you cannot use a stoker advantageously. If your boiler plant is small you may not effect a large saving in labor by the use of a stoker, but you can gain greatly increased boiler efficiency, save fuel, and correspondingly lower your operating costs.

After your stoker has been installed the first thing to do is to determine standard practice for firing. A little experimental work done by one of your competent engineers will enable you to lay down the rules to be followed in handling your stokers. After the standard practice has been formulated it should be typewritten and placed at one or more points in the boiler-room and the work of the fireman should be checked regularly. Remember that rules are of value only if they are followed.



STOKER INSTALLATION IN A WELL-KNOWN POWER HOUSE.

Be sure that the following points are embodied in your rules for stoker operation:

A—Keep draft under close control at all times. It is very desirable to use draft gauges with all types of stokers.

B—See that your air vents are kept open, so that there will be no obstruction to the passage of the air.

C—Do not allow air leaks which may develop in the furnace to remain unattended to.

D—See that the ash pit is cleaned out regularly at frequent intervals. Check up the CO_2 in your flue gas regularly. If the percentage falls below standard find out why.

E—Remember that coking coal may require the use of a slice bar.

F—Do not under any circumstances get water upon the arches or brick work when you are washing out the boiler.

G—Do not stop the stoker engine when hopper is full of coal. If an emergency stop is necessary, clean out the hopper.

H—Attend to all maintenance work promptly and your repair bills will be small.

In conclusion, if you wish a high standard in boiler room practice equip your boilers with the necessary apparatus and assure yourself that your operatives are sufficiently familiar with the equipment in the plant to handle it intelligently under varying conditions of load.

Mr. E. L. Walker, assistant engineer in the plant of Messrs. Goldie and McCulloch Company, Galt, has the following to say about Power House: "I think that the course of instruction for the graded certificate now running in Power House is unsurpassed as a means of helping the engineer qualify for a higher certificate, and I am now making use of it in studying for my second class papers."

John P. Campbell, 114 State street, Galt, has just completed forty years' consecutive service as chief engineer for the Galt Knitting Co., Ltd. Mr. Campbell has been a subscriber to Power House for the past ten years, and when his eyesight gave out for reading purposes six years ago, Mrs. Campbell read it to him until her death three years ago. Since that time Mr. Campbell's son has done this for his old dad. When the writer called for Mr. Campbell's renewal, the latter said that he looked forward to the arrival of P. H. every two weeks with interest unsurpassed by any other event. Mr. Campbell has been in the engineering business in Galt for forty-five years. He will be seventy-one years of age next week, and right here we want to extend to Mr. Campbell our heartiest good wishes for many happy returns.

Mr. G J. Christie, chief engineer of Wisers Brewery, Prescott, Ont., has just completed twenty years of continuous service with that institution. Mr. Christie was born in Dublin, Ireland, in 1872, and came to Canada in 1886. He went in for lake boat engineering and sailed the lakes for fifteen years as an engineer. He entered the employ of Wisers in 1901. He is a keen reader of Power House, and says he will always manage to soak away $2 for his annual subscription.

Points on the Principles of Refrigeration

General Idea of the Refrigerating Cycle—A Few Common Definitions—Various Types of Refrigerants—The Different Systems of Refrigerating Cold Air — Compression — Absorption Machines

By "FRIG"

A GREAT many engineers who are familiar with steam and its elementary principles find a difficulty in understanding the refrigerating system, especially when they have had no opportunity to see it actually at work.

There should be little difficulty for a man who understands the broad principles of the steam engine to grasp those of the refrigerating machine. The processes in one are duplicated in the other, but in an opposite direction. Definite units are employed to define them, as in the steam engine, and there is a large amount of literature available from the most elementary to the most advanced methods of explanation. The purpose of this article is to define in a general way the principles and terms used for the benefit of those who have little or no acquaintance with this important side of engineering and create an interest that will induce them to pursue the subject further.

The Refrigerating Cycle

The performance of work by a steam engine is brought about by a working fluid, a source of heat which changes the working fluid from a liquid to a gas, the giving up of the heat stored in the working fluid by doing work on the piston of the steam engine, and the changing of the gas back to a liquid in a condenser, from which it is returned to the source of heat. In more familiar language the furnace is the source of heat, the water in the boiler is the working fluid, which is turned into steam by absorbing the heat from the furnace. A portion of this heat is given up by the expanding steam forcing the piston in front of it, and the greater part is carried away by the circulating water of the condenser. The condensed steam is pumped back into the boiler. If everything on boiler and engine were tight, the original charge of water would do indefinitely, but owing to leakages here and there a certain amount is lost and must be made up from time to time.

In the refrigerating system the source of heat, the working fluid, the piston and the condenser are all present, but their operation is reversed. The working fluid is a volatile liquid usually of low boiling point and high latent heat. The source of heat is the medium which is to be cooled, and may be the air of the room or a solution of brine. The working fluid which goes into the evaporator of the system, which corresponds to the boiler of the steam system, is changed from a liquid into a gas, absorbing heat from its surrounding bodies as the water absorbed heat from the furnace. It is then drawn into the compressor, which corresponds to the cylinder of the steam engine, but instead of doing work on the piston, it is compressed by the piston. In other words the piston of the compressor performs work on the gas, the result being that a further amount of heat appears in the gas. It is then discharged from the compressor into the condenser, where the heat is carried away by the circulating water, and the gas becomes a liquid again, ready to pass to the evaporator and perform the same cycle again. Now in both cases we have the application of heat to change a liquid into a gas, and the giving up of heat to the circulating water. However, we have the important difference that in the steam engine the fluid does work on the piston, while in the refrigerating machine the piston does work on the fluid.

In both these cases the first law of thermo dynamics is made use of, which is "Heat and work are mutually interchangeable, and produce every unit of heat required for its appearance, or produces by its disappearance 778 foot-pounds of work."

Some Definitions

The unit of work is the foot-pound, which is the work performed by lifting a weight of one pound one foot in height. The unit of heat is the British thermal unit, which is the amount of heat required to raise one pound of water one degree when at its maximum density, that is from 39 to 40 degrees F. The amount of heat that will raise one pound of water one degree or the B.t.u. is capable of performing an amount of work equivalent to raising one pound weight 778 feet high, or 778 pounds in weight one foot high.

As there is a unit for the work done by the steam engine, which is known as the horsepower, so there is a unit for the refrigerating machine, which is known as the refrigerating ton, or ton of refrigeration. The purpose of the refrigerating machine being to produce lower temperature or extract heat, its work is measured by a unit that easily expresses that capacity. A ton of refrigeration is the amount of heat that would be absorbed by one ton of water being changed into ice from and at the temperature of 32 F. in the space of twenty-four hours. The amount of heat would, of course, correspond to the latent heat of water, which is 144 B.t.u. per pound, or 288,000 per ton. Therefore the ton of refrigeration is the absorption of 288,000 B.t.u. per twenty-four hours. Latent heat is the amount of heat which must be absorbed by a body or given out by a body in order to change its state, at a constant temperature. That is in turning water into ice or ice into water, at a temperature of 32 degrees F., in the first case there will have to be given up by each pound of water 144 B.t.u. to the surrounding air or other medium, which does not affect the temperature in any way, but which must be given up before the water can turn to ice. Similarly when ice is turned to water, before the change can take place, the ice must absorb 144 B.t.u. from the surrounding body which has no effect on its temperature, before it can change its state. Boiling water at atmospheric pressure has a temperature of 212 degrees, and in order for the water to become steam at the same pressure and temperature each pound of water must absorb 966 heat units which in no way affects its temperature, but is necessary in order to change its state.

Latent heat alters with the pressure and temperature of steam and water and the latent heat of other volatile liquids is different for each one of them, but there are accurate tables available which give the latent heats and boiling points of any liquid in common use.

It is the high latent heat, or capacity of storing heat, that makes steam so well available for the purposes of turning heat into mechanical work, in the steam engine, turbine, etc. Its high latent heat would be of advantage in using it for a refrigerating medium, only that it is offset by its high boiling point which makes it unsuitable.

What is required for a successful refrigerating medium, or working fluid for a refrigerating machine, is a liquid which will volatilize at a low temperature, while still possessing a comparatively high latent heat, and is capable of being liquefied again at a comparatively low pressure. The reasons for this are easily seen. It is by extracting heat from the medium surrounding the refrigerator that the liquid is turned into a gas. Now the higher the latent heat of the refrigerating fluid the more heat will be extracted from the surrounding body per pound of refrigerating fluid. On the other hand, if the boiling point of the refrigerating medium is high, the temperature of the surrounding body would have to be still higher for an exchange of heat to take place, therefore it is imperative that refrigerating medium must have a boiling

point lower than the lowest temperature that is required in the body to be cooled. The question of being liquefiable at a comparatively low pressure is an important one, as otherwise it means that the machine will have to be enormously heavy in build and correspondingly expensive.

It can readily be seen that for the above requirements only a medium possessing low boiling point and high latent heat is available. Fortunately we have several of these in commercial use. Probably the most generally used is ammonia. Ammonia has, at atmospheric pressure, a boiling point at —26.4 F. or 26.4 degrees below zero. Its latent heat at that pressure and temperature is 543 B.t.u. so that in order to vaporize one pound of saturated ammonia at atmospheric pressure the surrounding body must give up 543 B.t.u.

Carbonic acid gas, which is also used to some extent, and very much in marine refrigerating machines, requires the use of much higher pressure than ammonia. For instance, the boiling point of carbonic acid gas when at a pressure of 183 pounds is 30 degrees below zero, and its latent heat at this pressure and temperature is 140. Other mediums are sulphur dioxide, or sulphurous acid, and ethyl chloride which is used to some extent in small household machines.

Types of Machines

The various types of machines consist of cold air, compression and absorption machines. The cold air machine is practically out of use as it requires a large amount of machinery and takes up considerable room. Its construction is briefly as follows: There is a steam cylinder, and two air cylinders, with the necessary pipes for carrying the cold air to the rooms to be refrigerated, and pipes for circulating cold water. Air is drawn into a small cylinder, or in other words is driven by the steam cylinder. It is compressed in this cylinder, which is water jacketed to carry off the heat caused by compression. From the small cylinder it is discharged to a larger cylinder, and is allowed to do work on the piston of this cylinder, thus giving up heat and reducing its temperature. It is then discharged to the pipes which circulate round the room to be cooled, and the heat of the room is absorbed by the cold air, which is then drawn back into the cylinder to be recompressed. Thus we have the cycle again. Work is done upon a refrigerating medium, which appears in the medium in the form of heat. This heat is rejected partially by the circulating water, and then the intrinsic or latent heat as well as the remainder of the sensible heat is given up by performing work on a piston. The medium then circulating in contact with the body to be cooled absorbs heat from it, which replaces the latent heat in the refrigerating medium, and thus becomes lowered in temperature. The refrigerating medium has now made up the latent heat, but is at much lower temperature than it was formerly. In going through the cycle again, work is done upon it, which brings its temperature up again, and the cycle is repeated. In a perfect refrigerating machine the work done on the refrigerating medium and appearing as heat, which is rejected to the condensing water, should be exactly balanced by the heat units drawn from the body that is being cooled, but of course no machine effects this result exactly. The closer it comes to it the higher its efficiency.

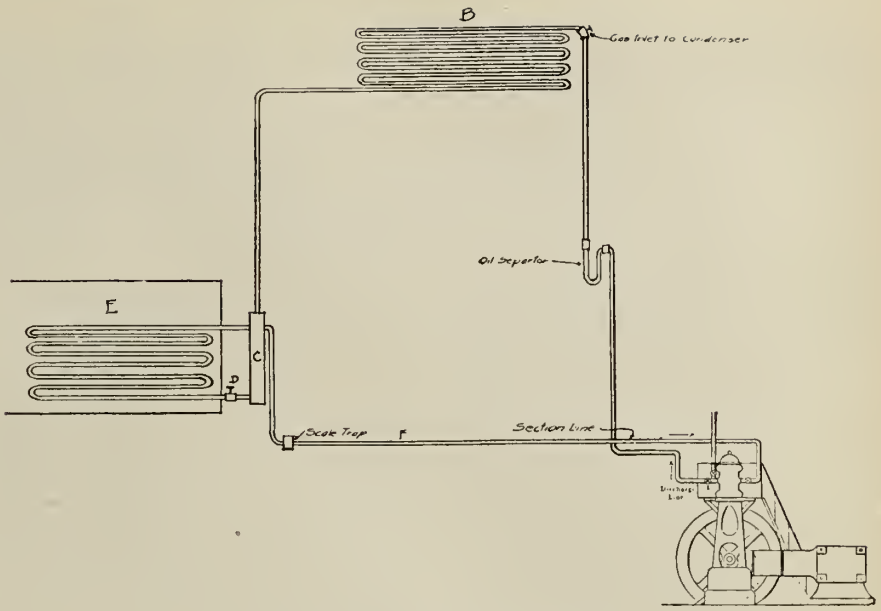


DIAGRAM OF COMPRESSION SYSTEM.

The Compression System

The compression system using a volatile liquid is based on the same principle. A charge of ammonia gas at low pressure and temperature is drawn into the compressor cylinder, and is then compressed by the piston of the compressor. Being compressed to a smaller volume, it has work done upon it, and this work appears as heat, the temperature of the gas being very much increased. Part of this increased temperature is carried off by the water jacket surrounding the compressor, or else by the vaporization of a small amount of liquid in the cylinder, but the gas is discharged from the compressor to the condenser at a higher temperature than that of saturation, which prevents it liquefying. In passing through the condenser this extra or superheat is given up, and also the latent heat which was in the gas, leaving it at the bottom of the condenser in the form of a liquid again, at high pressure, and a temperature about that of the condensing water discharge. From there it is passed through a small regulating or expansion valve into the evaporator, or direct into coils in the room to be cooled. It immediately expands, and if there were no heat available to turn it into a gas would remain as a liquid at low temperature. However, the surrounding medium contains heat which the refrigerant absorbs, thus enabling it to become a gas again, and in doing so reducing the temperature of the surrounding body. Thus we have again work done on a medium producing heat. This heat, which is shown in increased temperature, is given up to the circulation water, and besides this the latent heat of the gas is also given up to the condensing water, allowing the gas to become a liquid. This latent heat is taken out of the body to be cooled, reducing its temperature, and the refrigerating medium goes back to the compressor with its latent heat returned, but its temperature some 10 degrees lower than the body it is cooling. The temperature is again brought up in the compressor, and the cycles repeated.

The Absorption Machine

In the absorption machine there is no compressor used, but the same principle applies. The machine consists in general of a generator or distiller which is a cylindrical tank containing a set of steam coils and a quantity of liquid ammonia. There is also a condenser, and an evaporator, also an absorber. There are other appliances known as the exchanger and rectifier, and an analyser. The operation in general is as follows: Steam is applied to the coils in the generator, with the result that the liquid ammonia boils, and the ammonia gas is separated from the liquid, rising up precisely as steam does from water. It is under a pressure of about 100 pounds when leaving the generator. For the moment neglecting the intermediate apparatus, we may say it passes to the condenser, where it is reduced in temperature sufficiently to allow it to condense. It then passes to the evaporator or to the expansion coils through an ordinary regulating valve, where it again is transformed into a gas at low pressure and temperature, absorbing heat in

order to make the change of state. It passes then into an absorber, where the gas coming from the evaporator meets with weak liquor which is blown into the absorber from the bottom of the generator. This weak liquor absorbs the ammonia gas, and is thus turned into saturated ammonia liquid, and the pump then takes it from the absorber and returns it to the generator, where it is again boiled. The analyser is a tower in which are contained several cast iron plates or pans one above the other. The hot gas rising from the generator strikes the under side of these pans and heats them up. The rich liquor coming from the absorber comes in the top of the analyser and flows over these pans, thus being heated up to nearly the temperature of the outgoing gas. This serves the double purpose of heating the incoming rich liquor and cooling the outgoing hot gas. The hot gas on its way out contains a certain amount of water vapor, and after leaving the analyser it passes through the rectifier. This is merely a chamber containing coils through which the weak liquor coming from the absorber may circulate or a cold water circulation may be used. Its object is to cool the hot gas sufficiently to allow the water content to be condensed and returned to the generator. The weak liquid from the bottom of the generator which is blown by pressure over into the absorber passes on its way through the exchanger, which is simply a tank containing coils. The hot weak liquor in these coils is surrounded by the cool rich liquor coming from the absorber, and the temperature of the strong liquor is raised and the hot weak liquor is cooled. These are refinements for the better working of the system but the broad principles remain the same. The still and condenser constitute the high pressure side, while the evaporator and absorber constitute the low pressure side. The cycle is as follows: Heat is supplied to the ammonia liquid, which turns it into a gas, raising its pressure and temperature. The gas passes to the condenser where its sensible and latent heat are rejected to the circulating water, and it goes through the regulating valve to the evaporator or refrigerator in the form of a liquid at low pressure and about atmospheric temperature. Here it is again turned into a gas by the surrounding body, absorbing heat from it in doing so, and returns to the absorber in the form of a gas at low temperature and pressure. In the absorber it meets the weak liquor from the generator, which absorbs the gas and becomes saturated, and is then pumped back into the generator to repeat the cycle.

Brine Circulation and Direct Expansion

The difference between brine circulation and direct expansion is in the method for cooling the room or contents of a room. In the brine system the refrigerant is passed through a tank which contains a quantity of calcium chloride and water in solution, of sufficient density to prevent freezing. The solution in the tank supplies the heat to boil the liquid into a gas, and is then at its reduced temperature passed through the room to be cooled. Here it absorbs heat from the room to replace that which it has given up to the gas, and is returned to the evaporator to again give up this heat and be circulated once more. With the direct expansion system no brine is employed. The ammonia passes from the condenser to the ammonia coils which are situated in the room to be cooled, and the heat necessary to transform it into a gas is taken direct from the air of the room and its contents.

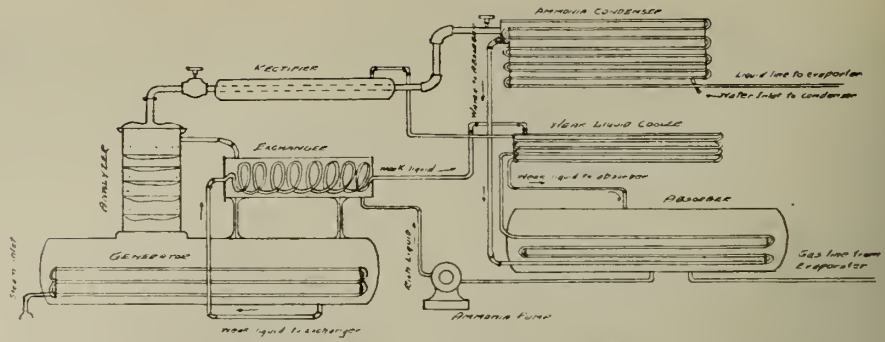


DIAGRAM OF ABSORPTION SYSTEM.

Conclusion

This article has dealt in a general way with the principles and practice of refrigeration, and is meant simply to give a general idea to those who have not studied the subject. It does not go into details, as this would take up too much space, but it should encourage those who want to understand this subject to look into more complete literature on the subject. The information contained here will be found useful for those contemplating taking the examinations for graded certificates.

TO INVESTIGATE U.S. LIGNITES

Dr. Erich W. Zimmerman, professor of commerce of the James Millikin University, Decatur, Ill., has been detailed by the United States Bureau of Mines to make an investigation regarding the fuel situation in the Dakotas, Minnesota and nearby states with a view to determining the extent to which carbonized lignite might find a market in that general region. Dr. Zimmerman will make a close study of the fuel supplies available in the northwest, the characteristics of these fuels and the prices obtained therefor.

The detailing of Dr. Zimmerman to this work marks a further advance in the investigation regarding the possibilities of increased utilization of the northwestern lignites for which the sum of $100,000 was appropriated by the sixty-fifth congress. Recently W. W. Odell, fuel engineer of the Bureau of Mines, was sent to Montreal and Ottawa for the purpose of effecting an exchange of information with the Canadian Government relative to the technical problems involved in the carbonization of lignite. The Dominion Government has for some years been working upon the problem of the utilization of the vast stores of lignite in the Western provinces and has spent several hundred thousand dollars in these investigations. The visit of Mr. Odell resulted in the obtaining of much valuable information. The Bureau of Mines is now assured that the lignites of the northwestern states can be converted into a high-grade smokeless fuel, the process yielding quantities of gas, ammonia, oils and tars as valuable by-products. With the practicability of the carbonization process assured, it remains only to consider the economic side of the situation, and to determine whether the carbonized lignite can compete with the high-grade coals of the central Mississippi and Ohio valleys, which are now being shipped by long freight hauls into the northwest.

The nation's coal resources of all ranks total 3,553,637,100,000 minable tons of 2,000 pounds, 1,051,290,000,000 tons, or nearly one-third, being lignite. Of this lignite 964,424,000,000 tons is in North and South Dakota and northwestern Montana, approximately 23,000,000,000 tons in Texas, 7,404,300,000 tons in Alaska and relatively smaller quantities in several of the other western and southern states.

OBITUARY

The death occurred last week in Galt of Jos. Flaherty, who for the past thirty-seven years has been chief engineer for the Canadian Cereal and Flour Mills, Ltd., of Galt.

In the death of Mr. Flaherty the Canadian Cereal and Flour Mills lost a good engineer and the community a good citizen who was respected and admired by all.

Mr. Flaherty was on duty till the day preceding his death, which was from natural causes.

A Treatise on Modern Refrigeration*

Definition of the Law of Thermo Dynamics—Comparison of Rankin Cycle—Refrigerating Mediums—Use of Refrigeration—A Discussion of Various Styles of Insulation in Use

By PROFESSOR J. WEMYSS ANDERSON

THE author in recent years has written a number of papers dealing with refrigeration, the chief of which have been read before the Institution of Mechanical Engineers, the Cold Storage and Ice Association, and the Liverpool Engineering Society, and the author would refer members in quest of detail to those papers.

The object of the present paper is:

a. To stimulate the interest of the mechanical engineer with good knowledge of heat engine work in the general question of low temperatures, and to show him that his knowledge of fundamentals will carry him a long way—a very long way—in the study of refrigeration.

b. To appeal for a wider theoretical and technical knowledge of the reversed heat engine, and, as a direct consequence, for wider applications of low temperatures to industries.

c. To appeal, in a university city, for post-graduate instruction and research in the subject, and for funds to carry out the same in your district.

Refrigeration

Refrigeration may be defined as a process for making a quantity of matter colder than its surroundings.

The laws of thermodynamics, which, of course, permit of refrigeration, have been expressed in various ways, but the most suitable for the subject under discussion are:

1st Law. Heat and mechanical energy are mutually convertible, and Joules' equivalent gives the rate of exchange.

2nd Law. It is impossible for a self-acting machine, unaided by any external agency, to convey heat from one body to another at higher temperature. (Clausius.)

The second law admits of the possibility of making bodies colder than their surroundings, but states that an expenditure of energy is necessary.

In modern refrigeration on a commercial scale mechanical energy is most usually employed — generally obtained by the expenditure of heat in a heat engine, which in turn drives a vapor compression refrigerating machine. Heat, however, can be directly utilized in an absorption refrigerating machine, and it would appear that a development of this style would make for greater efficiency.

It is, therefore, clear, by combining the two laws of thermo dynamics, that the effects required in refrigeration, i.e., extraction of heat, can be produced by the expenditure of heat in a suitable machine or combination of machines. The over-all efficiency of such a combination would be given by the ratio of the heat expended to the heat extracted.

For the conditions that obtain in, say, cold-storage work, the ratio, for the refrigerating machine only, is about 1 to 5, i.e., one thermal unit expended will extract five thermal units from the body cooled. This "efficiency," being greater than unity, is generally termed "coefficient of performance." The five thermal units so extracted cannot, by any possible means, be converted into an efficient source of mechanical energy, as it constitutes what is known as "unavailable heat." The one thermal unit expended is generally the heat equivalent of available energy.

Thus, the energy in a torrent of ice-cold water could, by the combined use of a water turbine and a refrigerating machine, be made the source of a very efficient warming appliance, but by no means could the heat equivalent of the energy in the torrent be made available, efficiently, as a source of heat in a heat engine.

Kelvin, in 1852, pointed out the possibility of a refrigerating machine being economically employed for warming purposes, but he also enunciated what has just been stated, re the torrent of water, in another form: "It is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of surrounding objects." As a further example of this method of expressing the second law, it can be stated at once that liquid air cannot, efficiently, be employed as a source of mechanical energy.

	Steam Engine.	Vapor-Compression Machine.
Flow of Heat.	Down.	Up.
$T_1 p_1$	BOILER. — High temperature heat, quantity H_1 transferred from fuel to the water forming steam at $T_1 p_1$.	CONDENSER.—High temperature vapor at $T_1 p_1$ condensed into liquid. Heat rejected H_1.
	CYLINDER —Part of heat, H_1 in the steam converted into mechanical energy, remainder. H_2 sent into condenser at $T_2 p_2$.	COMPRESSOR. — Energy expended (AW) in compressing vapor at p_2 into vapor at p_1. Total heat sent into condenser $= H_2 + AW = H_1$.
$T_2 p_2$	CONDENSER.—Steam at $T_2 p_2$ condensed into water at $T_2 p_2$. Heat rejected $= H_2$.	EVAPORATOR.—(Refrigerator) Heat, quantity H_2, extracted from body to be cooled by means of vapor at $T_2 p_2$.
	FEED PUMP.—Energy expended in pumping water at $T_2 p_2$ back into boiler at $T_1 p_1$.	REGULATING OR EXPANSION VALVE. — Liquid from condenser at $T_1 p_1$ allowed to pass freely into evaporator at $T_2 p_2$. Energy not utilized.
Efficiency.	Heat utilized $= H_1 - H_2$. Heat expended $= H_1$. Ratio of heat expended to heat utilized $= \frac{H_1 - H_2}{H_1} = \frac{T_1 - T_2}{T_1}$	$H_2 + AW = H_1$ (from above) $\therefore$ $AW = H_1 - H_2$ = heat expended. Ratio of heat extracted (H_2) to heat expended $= \frac{H_2}{H_1 - H_2} = \frac{T_2}{T_1 - T_2}$

*Transactions of the Institute of Shipbuilders and Engineers in Scotland.

The refrigerating machine is a heat pump, and, as such, is the reverse of a heat engine. The vapor-compression machine in common use to-day is the reverse of the steam engine working on the Rankin cycle, and many of the researches, improvements, and discussions which have marked the progress of the steam engine can be applied with advantage to the vapor-compression machine—remembering always the question of reverse action. Thus:—

1. Range of Heat. In the steam engine the greater the range T_1, T_2, the greater the efficiency; in the refrigerating machine the smaller the range the greater the coefficient of performance.

2. Medium. The medium in the steam engine is water which under normal atmospheric conditions is liquid, and one of the main objects in the whole operation is to convert this liquid at T_2p_2 into a vapor at T_1p_1. The medium in the refrigerating machine under normal conditions is a vapor at T_2p_2, and one of the main operations is to convert this vapor into a liquid at T_1p_1.

3. Feed. The hotter the water forming the feed into the boiler the greater the efficiency, and any available heating effect should be utilized. The colder the feed of the liquid refrigerant into the evaporator in the refrigerating machine the greater the coefficient of performance. Mr. G. W. Daniels,* M.Eng., has shown that an auxiliary refrigerator used to reduce the temperature of the feed in a carbonic anhydride machine cooling at —50 degrees C. resulted in an increased refrigerating effect at 75 per cent., with an increase in horsepower (including that required for the auxiliary machine) of about 27 per cent., while the overall saving was 27 per cent.

4. Condensation and Vaporization. Bearing in mind the statements under 2, it is important that the steam should remain steam while operating in the engine, any water formed at any stage should be rejected at once to the hotwell, its function being over, and its presence detrimental. Likewise, any vapor formed, at any stage, in the refrigerating machine should be transferred to the condenser as soon as possible, as its function is over. In passing the regulating valve, some of the liquid vaporizes to cool itself from T_1 to T_2. This vapor represents a definite loss, and anything that can be done to reduce this loss is, of course, a gain. Cooling the feed, as mentioned under 3, is one way, and is really the reverse of superheating the steam supply, which not only increases T_1, but reduces condensation in the steam engine. Another method of reducing the loss by vaporization on passing the regulating valve is employed by Mr. Voorhees in his "multiple effect" CO_2 refrigerating machine.*

*"Some Recent Developments in the Theory and Practice of Refrigerating Machines." — Trans. Liverpool Engineering Society, 8th January, 1919.

5. In the cylinder of the steam engine any means such as lagging and steam jacketing, that will keep the steam from condensing and prevent heat "leaking out," has been advocated and discussed at length. In the refrigerating compressor, anything that can be done to prevent heat "leaking in," and actually encouraging heat to "leak out" from the compressor, and thus prevent superheating, should be done. Water jacketing under some conditions is a great advantage, heat being removed thereby by the water. Unaflow compressors are also employed, which keep the cold vapor at one end and the compressed hot vapor at the other.

The above five reverse parallel cases suffice to illustrate the point raised, and steam engineers taking up refrigeration should bear the "reverse" action in mind —they will soon find their knowledge of great value. Research on the points enumerated is much required in refrigeration, as nothing like the work has been done in this section corresponding to the steam engine side.

Refrigerants

Water has never been seriously challenged as the medium in the vapor-expansion heat engine, but in the vapor-compression heat pump many media have been tried, but carbonic anhydride (CO_2) and anhydrous ammonia (NH_3) hold the field, while sulphurous anhydride (SO_2) is also used.

Ethyl chloride (C_2H_5Cl) is now being used with a turbo-compressor and this machine corresponds to the reverse of a steam turbine.

The chief characteristics of the principal refrigerants are given in the following table:

	Temp. F.	Abs. pressure Lbs. per square inch.	Specific Volume. Liquid.	Specific Volume. Vapor.	Heat Content. B.Th.U. Lbs. Liquid.	Heat Content. B.Th.U. Lbs. Vapor.
CO_2	0°	308	0.016	0.20	—13.5	103.0
	75°	904	0.022	0.07	+31.5	88.3
NH_3	0°	30	0.024	9.2	—33.7	538.5
	75°	141	0.027	2.1	47.8	556.0
SO_2	0°	10	0.01	7.1	— 9.9	152.0
	75°	54	0.01	1.5	14.4	162.0
C_2H_5Cl	—4°	3.6	0.016	21.3	—15.4	163.0
	77°	22.94	0.018	3.84	19.2	183.5

These figures indicated at once that the refrigeration per unit of compressor volume was relatively great for CO_2 (i.e., small compressor), medium for NH_3, and small for SO_2 (i.e., largest compressor). Against these facts, the working pressures and pressure difference in the CO_2 machine are very heavy, and are very light with SO_2. The heavy working pressures told against CO_2 in the early years, but more experience and high-class workmanship have lately favored this refrigerant. Reliable tests and research are greatly needed to indicate which is the more efficient machine, CO_2 or NH_3, and in what ratio.

The author, in 1912,* had written: "In his own opinion, a captain who went into action with his refrigerating machine charged, either CO_2 or NH_3, committed a grave error of judgment—with NH_3 for the reasons just given (appalling effect of a burst ammonia pipe on the crew), and CO_2 because of the risk of asphyxiating the men below decks." This advice had not been followed in the late war, until our warships had been in action and had proved the necessity of blowing off the charge, when orders were issued accordingly.

With reasonable precautions—on land and on sea—no danger need be feared from the use of either refrigerant. The same type of precautions that prevented steam, products of combustion, and ash dust reaching the passengers or crew (or both) at sea is all that is necessary to dismiss any discussion as to the better refrigerant to use on ship board.

With respect to the future and immediate progress, while ethyl chloride may find favor by virtue of its rotary compressor—particularly for small plants—the author is of the opinion that quick-revolution vertical compressors, driven either electrically or by means of multicylinder vertical hot-bulb oil-engines, will prove the most satisfactory line of development. Many refrigerating engineers will not doubt favor a quick-revolution driving engine coupled by reduction gear to a slow-revolution compressor.

Use of Refrigeration

There are many important industries and branches of engineering that would benefit by the greater use of refrigeration—civil, mining, and electrical engineering, chemical, rubber, chocolate, margarine, and dye works, dairies, breweries, and distilleries, while the much-needed public up-to-date abattoirs would have chilling rooms as a first necessity. The great cities are fairly well supplied with cold stores, but the rural and urban districts should, also, from an economic point of view, be abundantly supplied with cold-storage facilities. In such developments the use of electrical methods for the transmission and utilization of energy should be carefully noted in con-

*See Sir Wilfred Stokes— Proc. Inst. of Mechanical Engineers, 1912, parts 3-4, p. 1130.

junction with refrigeration, as the latter requires more energy in summer than in winter, and could easily be made the means of devising a type of load that would be most acceptable to the electrical engineer.

Coal Storage and Transport. The greatest use of refrigeration at the moment is for the storage and transport of perishable produce. A cold store is nothing more nor less than a warehouse, where the air is "conditioned" to suit the produce stored—such as meat, ham, bacon, fish, poultry, game, rabbits, milk, butter, cheese, margarine, eggs, fruit, vegetables, wines, and beer.

The pioneer cold-storage owners built their stores and waited for the merchant to rent so much cubic feet of space. The successful cold-storage companies of today are traders in chilled or frozen produce who keep their merchandise to suit their customers' convenience. This, in turn, has resulted in regular lines or even fleets of steamers being built for the special purpose of carrying refrigerated produce, and run by cold-storage companies. Thus it is that the harvests of the world are equalized, and the produce of the antipodes brought in excellent condition to our very doors.

The engineer has been chiefly responsible for this success, which, in the main, has been worked out by the trial and error system. Now, however, the Department of Scientific and Industrial Research has a food investigation board (originally established less than three years ago as a cold storage research board) at work, and it is confidentially to be expected that the rule-of-thumb methods now obtaining in cold storage will be replaced by rules framed, as the name of the department suggests, by a right combination of scientific and industrial effort.

It would be useless to deny that cold-stored food is the success that nature's own method of preservation merits—it neither tastes nor looks, for the greater part, like the fresh product. The author, after long experience, is of the definite opinion that, with reasonable (i.e., commercially possible) care, most foods would improve with low temperature treatment.

Milk, intended by nature only for feeding the very young, and even then by passing direct from the mother to the offspring, is perhaps one of the most unstable foods in general use. Yet, by the aid of refrigeration and common-sense hygiene, it can be kept perfectly sweet for weeks.

Fish, another very unstable food, can be kept in the best condition by preventing bruising and by the aid of refrigeration. It cannot be pleasant for a Scotsman to know that before the war 25 per cent. of the Aberdeen fish reaching London was from German fishing boats. Why? Because up-to-date commonsense and low temperatures went hand in hand. It is not suggested that either milk or fish should be frozen — only chilled.

The fish problem of Great Britain will not be met by freezing, but by careful handling, chilling (careful icing probably the best), and rapid transport. The herring, for instance, moves around Great Britain in a most leisurely fashion, producing gluts at fishing centres at stated and regular intervals. The problem of getting these valuable fish into the industrial centres could easily be met by herring trains, which would follow the movements of the fish, and thus meet and ease the gluts. The Ministry of Transport could help in a matter of this kind, and refrigeration would be a great aid.

Insulation

In the construction of cold storages and in the insulation of ships' holds most curious mistakes are still made (in books and in practice) on the assumption that the sole object is to "keep the cold in," whereas the true problem is to keep the heat out, and anything that can be done to dam off the influx of heat is to the good. Thus a warehouse in the form of a cube, where the weatherproof and airproof walls do not carry any of the weight of the stored material (i.e., girders not built into the walls), and are thoroughly insulated without break from top to bottom, are the first essentials of a good cold store. A properly constructed roof or ceiling and basement floor being assumed as part of the "walls" of the cube, it only remains to be said that, from a constructive point of view, openings at the top only for the goods complete the requirements.

The subject of insulation is a very much discussed one, but Prof. Thornton, who has made a special study of the subject of insulation for cold-storage work, has made a great step forward in the matter of the conduction of heat (perhaps "resistance to heat flow" would be a better term) in his paper in the "Philosophical Magazine." The following table (extract) is there given:

Material.	Density p.	Elasticity, E. 10^{-11}	Velocity Sound V. cm. sec. 10^{-5}	Epx 10^{-11}	V^2p^2x 10^{-11}	Thermal Conductivity, k, in Calories observed.
Graphite	2.3	5.25	4.65	12.1	11.5	12.0
Marble	2.7	2.6	3.10	7.0	7.0	7.1
Mahogany, Honduras	.62	.88	3.7	0.54	0.52	0.5
Deal	.5	.9	4.2	0.45	0.44	0.4
Ice	.91	.28	1.74	0.25	0.25	0.22
Paraffin Wax	.91	.151	1.30	0.137	0.14	0.141
V. India-rubber	1.02	.05	.07 .7	0.05	0.0005 0.05	0.45
Cork	0.24	.0055	.48	0.0013	0.0013	0.13

"It was not to be expected that a quasi-solid such as india-rubber should conform to the rule. Its velocity of sound, calculated from E and p $0.7.10^5$, centimetres a second; the observed value is $0.07.10^5$. In either case the values of Ep or V^2p^2 are of a lower order than the conductively observed by Lees, though the numeral is the name."

These results are of the utmost importance to those interested in cold storage work, and point to the possibility of definite laws being formulated respecting the transfer of heat, which would hold good for all temperatures and all temperature differences within changes of state.

Prof. Thornton concludes:

"The object of the present note is to direct attention to the above relations between k, E, p, and V, which must be explained by any theory of conduction in non-metallic solids. The chief practical qualification of a material as a heat insulator is that it should be light and inelastic."

It is not to be supposed that with definite laws of the transmission of heat, and a thorough investigation of the conditions obtaining generally in cold-storage work, the problems of the refrigerating engineer would be solved. The electrical engineer has very definite knowledge of the various insulators he employs, and this, to a certain degree, has led to a standardization in the most ordinary cases. Yet a variety of circumstances leads him to vary his practice to suit ever varying conditions, and he is, of course, able to test his insulation before the current is laid on, and during the lifetime of the installation. The expert refrigerating engineer does, of course, vary his practice, but in the majority of cases the want of definite direction leads to rule-of-thumb practices applied without the least discrimination.

Thus, in a cold store, where trouble had been experienced with the insulation, and recently brought to the notice of the author, it was found that the southeast corner chambers, with two exposed walls, had exactly the same insulation as the north chambers, with one exposed wall. The insulation contractor concerned stated this was the usual practice. It has not been the author's practice.

The main conditions that determine the thickness and type of insulation are:—

a. The cubic capacity, use, and shape of the stores. Thus, a store of 50,000 cubic feet, rectangular in plan, intended for freezing produce, should have a better insulation than a store of 750,000 cubic feet, with a square section intending for storing frozen produce. Ships' holds present a number of possible combinations—next to boilers, below sea level (water-washed surfaces), above sea level (sun-heated surfaces), and the possibility of the hold being submerged.

b. The position and construction of the wall. A well-constructed 14-inch brick wall on a north side would require much less insulation than a reinforced concrete wall on a south side of a store. Concrete walls require much care and attention, and every effort should be made to obtain a non-porous exterior finish, with three or four coats of bitumen on the inside before any type of insulation is fitted.

The steel walls of a ship present an unequalled condition for allowing heat to "leak in," and it is only now that careful differentiation is being understood, but nevertheless too much rule-of-thumb still prevails. During the war it was found that beef in the top corner of a hold at the ship's side was not in good condition, and a "ribbon" of insulation, about four feet wide, was placed fore and aft on the top, inside the chamber, next to the ship's side. This, no doubt, under the conditions, was good practice, and with timber or ferro-concrete beams would have been sound practice on land, but the succeeding trip showed that the trouble had only been partially solved, inasmuch as while the beef in the corner near the ship's side was sound, the meat nearer the centre line, and just outside the ribbon, was a bit off color—i.e., the heat meeting additional resistance, in the shape of the ribbon, travelled along the beams to the region beyond the ribbon.

Again, on ship board, in chambers designed for carrying chilled beef a degree variation in temperature is a matter of moment. A ship passing through the tropics, therefore, must have an insulation quite equal to that in a ship designed to carry frozen goods. Thus, particularly in ship work, the conditions a and b are interdependent.

c. Material and labor and local conditions.

Insulation requires very great care, skill and experience for successful construction. If, say, charcoal or slag wool is used, the greatest care is required to make the sheathing airproof and waterproof. On ship board, with the thin steel work, scamping would lead to heat leaks that might in turn lead to the loss of thousands and thousands of pounds. It is easy to specify an efficient insulation in this country; abroad, however, the difficulties with either or both materials and labor might reduce the value of the same specification to a minus quantity.

Thus, in Japan, say, it might be quite good policy to use rice husks specially treated, because the skilled labor available is good, and careful supervision would ensure air, water, and vermin-proof casings.

Local considerations are most important. If trouble is to be expected from, say, white ants or rats, then tinned sheets must be introduced if boards are used as a sheathing. With the personal equation so prominent, it is not surprising that baked cork slabs built up by means of hot washes of bitumen, and finished off on the inside with a layer of special cement, have become so popular of late. It is not that cork is a better non-conductor than either slag wool or flake charcoal—it is that the construction approximates so closely to the ideal air and water-proofness.

Yet very serious danger lurks behind the use of cement in unskilled or inexperienced hands. Most cements are very porous, and mould and other spores are liable to collect in their millions on its surface. Cements, therefore, should be subjected to the same hygienic treatment that most careful managers insist upon in their cold stores; the surface should be carefully varnished, finished with white enamel paint, or whitewashed. The two former should be wiped over with disinfectant once a year, and the latter whitewashed every two years at least.

It must be reiterated that a large, well-constructed and insulated cold store, square in plan, offers no difficulties to the refrigerating engineer, but careful consideration of detail will keep down the first cost, and subsequent running expenses.

Education and Research

The previous portion of the paper will show that a good mechanical training, together with a sound knowledge of applied heat, is the first essential of an engineer who wishes to study the technics of low temperatures. In the United States, every engineering school of any standing has always a refrigerating laboratory attached to it. In Great Britain, there is not a single instance of such a laboratory. It is true that many laboratories have one or more refrigerating machines, but the entire absence of published research work clearly indicates that nothing of value is being done. Yet the field is very wide. Every corresponding step in the reversed cycle which has been the subject of research and discussion in the direct cycle offers ample scope for investigation.

The prejudice against frozen produce could be eliminated altogether with a better and wider scientific knowledge which would come from the researches of the bio-chemist and the bacteriologist. The transport by rail and road would also be greatly facilitated by a wider knowledge, while a proper understanding of the subject of food values would, without doubt, show that in the majority of cases food was often kept in cold stor until it was quite unfit for human con sumption.

A self-digestive action is always go ing on in meat at the temperatures i the ordinary cold stores, and a preserva tion of structure and absence of sme is no criterion of its soundness for ea ing purposes. It is true that the Foo Investigation Board has now much this work in hand, but it must rema for our universities and colleges to the necessary educational work, and firs hand knowledge of research is an esse tial of every teacher.

The latest report of the Departme of Scientific and Industrial Resear showed that the Government had agre to spend £30,000 for the erection of special cold-storage laboratory at Ca bridge. Glasgow and all other univer ties should be similarly equipped. Her in lies an opportunity for your citize to benefit science and the populace one stroke.

The Conveyors Corporation of Am ica, Chicago and New York, ta pleasure in announcing the appointme of Robert B. M. Wilson as sales engine of the Chicago district. With him w be associated as an assistant E. Wolfe. Headquarters will be ma tained in the corporation's main off at 326 West Madison Street.

Mr. Wilson has had a well-round experience in industrial engineeri Ten years were devoted to railroad co struction and maintenance, six of wh were spent in the republic of Mexi For five years he was special represen tive of a nationally known manuf turer, working among large industri plants in the central states. Since 19 he has been an associate member of e American Society of Civil Engineers.

During the world war he spent e larger part of his twenty-seven mon of service in France, receiving his di charge as major in the 311th Engine

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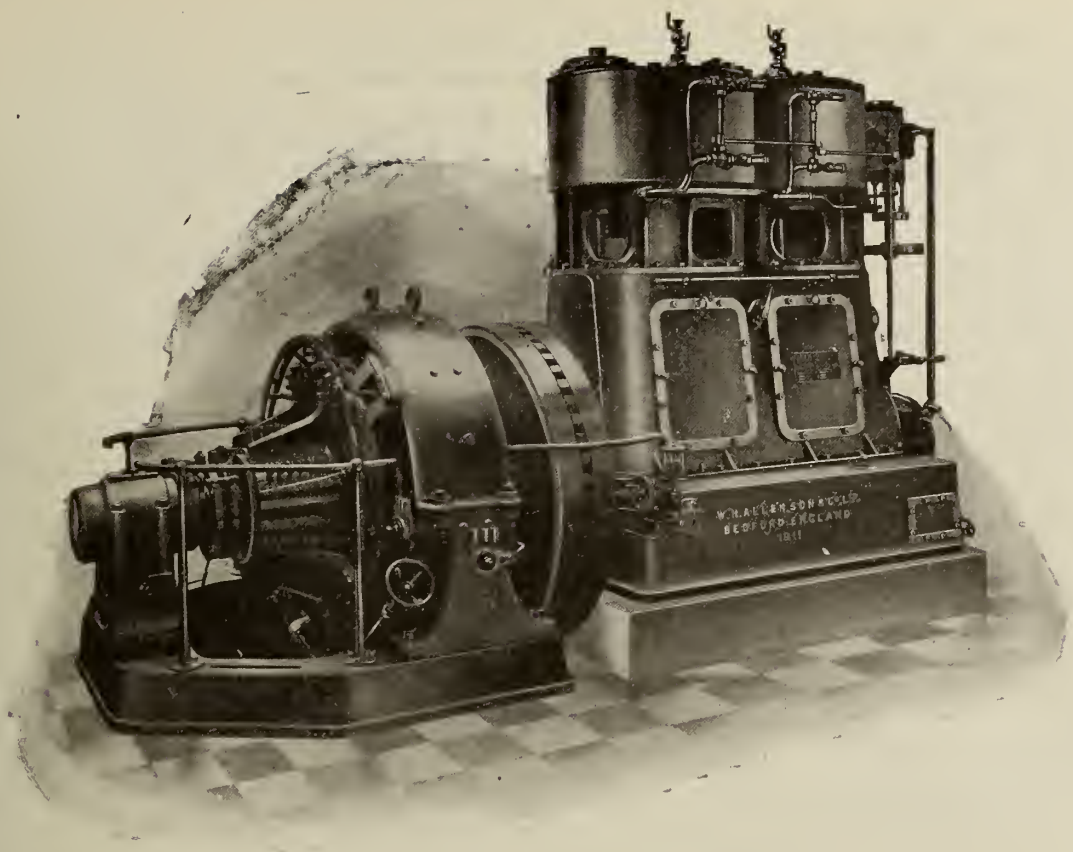

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Central Heating Plants

WE recently commented editorially on the advantages of the central heating plant from a general point of view. Since then we have had an opportunity of inspecting what is probably the largest central heating plant on the continent.

This plant, which will be fully described and illustrated in our next issue, is in connection with the new Parliament Buildings in Ottawa. It heats no less than nine buildings, the furthest from the plant being nearly one mile away. It has justified its existence by the savings it has made in its first year of operation and in our opinion it would be a better proposition still if operated as both a lighting and heating plant.

The pleasing feature is that the plant is to a large extent the product of Canadians. The consulting engineer who designed it and the contractors who carried it out and a large part of the equipment put into it are products of Canada.

There is no reason why this should not apply to more plants if Canadians would get away from the idea that they must go to the States for consulting engineers and architects. There is plenty of good material right in Canada as this plant so well testifies.

Refrigeration and Our Daily Needs

IT is perhaps not generally recognized, even among engineers, what a large part the production of cold by artificial means plays in our daily lives.

The milk we take in from our doorsteps in the early morning has been kept cool in its journey from the farm by refrigerated cars. These cars are cooled by blocks of ice which have been in many cases produced artificially. In the great city dairy, after the milk has been pasteurized, it is cooled down again by circulating in a tank which is cooled by the brine from a refrigerating machine. The cattle that come from Ontario farms are slaughtered in the city and the carcasses are kept sweet and wholesome until they are distributed in rooms chilled to nearly freezing point by mechanical means. Food that is produced in abundance at one season of the year can be kept in good condition for months, so that the supply will be available over the whole year. Many people think that this feature is the cause of high prices, but looking at the question broadly, one is forced to the conclusion that it is on the whole a wonderful benefit to humanity.

The comfort of those who travel at sea is vastly enhanced by the use of cold storage on the ship, while thousands of tons of frozen beef and mutton are carried from continent to continent in refrigerated holds of ships.

Minor luxuries, like candies, are likewise indebted to the refrigerating machine. Our picture shows and theatres are made comfortable and cool on the hottest days of summer by this beneficial agency. It even contributes its quota to sp[ort], by producing the ice that our fickle climate refuses us w[hen] we have every right to expect it.

One might enumerate many other things refrigeration [ac]complishes and its share in the manufacture of T.N.T. dur[ing] the war alone entitles it to a high place in our regard. [All] these wonderful achievements at so low a cost have been m[ade] possible first by the researches of those able scientists [who] labored so patiently to find the relation between heat [and] work, and who first discovered what heat really was. Foll[ow]ing them came the practical mechanical engineer who produ[ced] the necessary mechanism to apply the scientific laws and t[hey] placed their machines in the hands of the operating engin[eer]. On his ability and knowledge in the last analysis depends [the] success of any refrigerating machine and it should be the [aim] of every stationary engineer to acquire a knowledge of [the] principles of refrigeration at least equal to his knowledg[e] the steam engine.

More and more in the future will the stationary engi[ne] have to expand and this is one of the most important directi[on]s

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THE SECRET'S OUT

N. White, a boiler inspector on the staff of the Boiler Inspection & Insurance Co., has the following story at the expense of Power House. "Some months ago," said Mr. White, "I received instructions to inspect a boiler in a sawmill in the northern part of the province. I had quite a time finding the place, but after some little trouble came across it all right. It looked as though it had been built one hundred years ago, and was ready to fall to pieces. A little stagnant pond with moss-covered dead heads sticking up from the surface lay between the mill and myself, and I worked my way around it through a network of dead brush and stumps. An old man was sitting outside the mill on a pile of slabs, and he accosted me with a cheerful "Howdy?" and further inquired if I was the man who was going to inspect the boiler. Having answered in the affirmative, the old gentleman conducted me into the boiler room, where he introduced me to a young man, his son John. Answering some questions of the old man, I remarked that I would have to make some calculations. The young man looked up at this, and informed me he could give me all the necessary information and figure out anything that was wanted. So I told him to go ahead and figure the horsepower, bursting pressure, etc., expecting that he would be stumped. Much to my surprise, he produced pencil and paper and started right in to make the necessary calculations and explained them as he went along. After I got over my surprise I asked John where he had picked up all this, but before he could reply the old gentleman said, with paternal pride, 'Why, this is where they get the information for the Power House. John hasn't been here always. He has had charge of lots of plants and written lots of articles for the Power House.' I had nothing more to say after this, and came away from that mill feeling that you never know what you will strike next."

STRAIGHTENING ROTOR SHAFT

BY JOHN S. WATTS

I read with interest the article on straightening the rotor shaft on page 32 of January 20 issue of Power House. I noted that the editor questioned the method employed, because as he expressed it, the method adopted did not relieve the internal strain in the shaft caused by the bending. He suggested that the shaft should have been heated by a blow torch, straightened by pressure, and after being annealed at a dull red heat, trued up in the lathe.

As the bending of shafts and other parts, by rough handling in transit, or by accidental over-strain in operation, is of fairly frequent occurrence, I think it would be valuable to have this matter well discussed, in an effort to determine the one best method.

That it is impossible to get a bent shaft exactly straight again, by pressing out the bend, is well known to all who have tried it, and is apparently not disputed by the editor, who specifies trueing up the shaft in the lathe, as the final operation in his criticism. To do this means turning enough off the shaft, to permit the insertion of a bush, of a practicable thickness, in the bore of the pulley, to make it fit the shaft after it is trued. The bush would have to be at least an eighth of an inch thick, thus reducing the shaft one-quarter of an inch in diameter, and seriously weakening it at the point of greatest stress.

Possibly this reduction of diameter could be made just sufficient to true up the shaft by making or purchasing a new pulley to suit, but as these motor pulleys are finished all over and balanced, on account of the high speeds they run at, in nearly all cases the delay incurred in getting a new pulley with a special bore would be fatal. Experience in straightening shafts will show that in straightening out the one bend we infallibly cause another small bend, which in this case would occur in the bearing, and for a good job we would have to true up the shaft at the bearing, and so be compelled to also re-babbitt the bearing.

The main point the editor makes is that the shaft is under the permanent initial strain imposed when bent, and that this strain is not relieved by the heat of welding. In a long experience I have seen many bent parts straightened, mostly always cold, and have never seen any annealed after straightening, nor have I ever known any failure from this lack of annealing. It seems to me that practical experience proves that a slight bend which gives no indication of having been sufficient to impose a stress approaching the breaking stress, while it undoubtedly must have strained the shaft beyond the elastic limit does not actually injure the shaft permanently, as the strain in a comparatively short period of time disappears, presumably by readjustment of the molecules, to accommodate the new shape of the shaft. It takes, to my mind, as much pressure to straighten a shaft as it does to bend it, so that this bears out the above statement, within the limits of one or two bendings, of course.

If the bend is so severe as to cause cracks to show in the shaft, the strength of the shaft is obviously permanently impaired, and it would be useless to straighten it, but the bends actually met with are very seldom in this class. Unfortunately, we do not at present know much about the behavior of steel under stresses between the elastic limit and the breaking stress, but the fact that steel can be stressed beyond its elastic limit a few times and recover

Continued on page 42

Of course you don't! Such a thing would be preposterous. Yet, many concerns are doing this very thing, figuratively, when they use big, clumsy, heavy steam traps of the bucket or float type, instead of the small, highly efficient Steam Trap SARCO.

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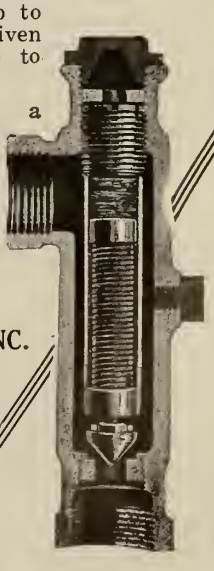

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HEATING RETURNS

Question:—Is it advisable to run returns from a heating system in a mill from the trap through the boiler blow-off? My opinion is that the mud in the boiler has a tendency to get under the check valve, thus causing it to groove.

Answer:—We think that the blow-off is a good place to deliver the discharge from the trap. It keeps the blow-off pipe clear, and there is little danger of the check being damaged when it is continually washed by the water flowing over it. If there is any objection against putting returns through the blow-off of a horizontal return tube boiler it is that this is the hottest part of the boiler. However, returns from traps are usually at the same temperature as the steam or but little below it, so there is not much objection to this practice.

* * *

SIDE PLAY ON SHAFT

Question:—A 7½ horsepower motor driving a four-ton York refrigerating machine. There is a side play of about half an inch on the shaft of compressor when running. What is the cause of this and is there any danger in running same?

Answer:—We presume that the compressor is driven from the motor by a belt, and this is probably the cause of the side play. Having the two pulleys slightly out of line will cause side play, and the same thing will occur with a belt that has not been spliced squarely. In order to have so much side play on the shaft of the compressor there must be plenty of side play in the connecting rod and guides, but even so half an inch seems a lot. Would advise you to examine the lining up of pulleys and compressor.

* * *

DEPOSIT ON COILS

Question:—What can I do to remove lime from the coils and valves of a hot water heater? The tanks have steam coils in them and the water surrounds the steam coils, the impurities in the water being deposited on the outside of the coils as the water is heated. I have tried putting a valve coated with this deposit in a solution of Gillet's lye without getting rid of the lime. I have also tried vinegar, which helped a little.

Answer:—You are having the same trouble which is met with in evaporators in marine service, which evaporate salt water and become heavily coated with scale. In these evaporators provision is made for easily removing the coils, which are then scaled by hand. It is perhaps difficult for you to do this, but if the coils are very badly coated I would suggest that you remove them and thoroughly clean them. If possible after that use a solution of soda in the water to be heated, which will tend to keep the scale in solution, and clean frequently. The deposit is probably sulphate of lime and gypsum, which is very hard, and difficult to remove when left long. A method used with evaporators where the coils are made of copper is to empty the water chamber and leave the steam on the coils. Cold water is then admitted rapidly, and the sudden contraction of the coils cracks off the scale in large lumps. However, we would not recommend that method with iron pipes, although they might stand it all right, the danger being in the fittings.

* * *

REDUCING STEAM PRESSURE

Question:—Can you tell me why there is any gain in fuel by raising the steam to 50 pounds and then reducing it to 10 pounds for heating purposes? My chief claims that the steam is superheated when expanded without doing work, but, as I see it, the heat must have been put into the steam from the coal to begin with. I can see where there are losses from such a system, such as higher first costs, more leaks, higher temperature in chimney gases, etc., besides needing a pump or injector to feed the boiler, and the services of a licensed engineer.

Answer:—There are cases where it might be of advantage to use steam of a higher pressure and reduce it at the point of delivery. For instance, in a long run of piping, where there may be considerable condensation, it would be better to have the steam carried at higher pressure, so that when it was reduced there would be re-evaporation. For instance, steam at 50 pounds pressure has a temperature of 298, and the total heat in the steam is 1,178.5 B.t.u. Steam at 10 pounds pressure has a temperature of 240 degrees and a total heat of 1,160.4. Now if steam is expanded from 50 pounds pressure to 10 pounds pressure without doing work it will have 58 degrees of extra heat in it, and a condensation in the pipe on the 50 pound side will immediately become evaporat on the low pressure side. However, you say, the original heat has to co from the coal. This principle of usi high pressure steam and then reduci it is often used to overcome condens tion difficulties, but there has to be consideration of all factors before it c be definitely decided on for any pa ticular purpose. You may rest assur that you do not get heat anywhere f nothing, and if you had ten cubic feet steam at a certain pressure and temper ture containing a definite quantity heat units, and expanded that ste without loss or gain by radiation or a other way you would still have the sa quantity of heat units whatever char might take place in volume and pr sure, so long as condensation did take place.

* * *

OIL BURNERS

Question:—Can you give me some a vice on oil burners for 12-inch boiler These are the latest type, fitted w down draft. The top draft can be clo and made to burn as an ordinary boi

Answer:—It is always necessary use refractory brick in the furnace wh burning oil. Would advise you to in touch with manufacturers of burn and get their advice as to installati Perhaps some reader of this column w has oil burners on this type of bo would help you out.

The Lakeside Bridge & Steel C North Milwaukee, Wis., have alm completed arrangements for represe tion in Canada. The company are ma facturers of steel frame structures machinery and are general engine They will be interested chiefly in sell and manufacturing the Labride handling equipment for the Canad trade.

The Fulton Iron Works Co., St. Lo U.S.A., have published a handson illustrated catalogue describing Diesel engine manufactured by the fi The booklet, after describing briefly he origin of the Diesel engine, and its working cycle, together with sc curves and tables of fuel consumptn continues with a detailed descriptiorbt the engine itself, which is well il trated.

The LABRIDE Coal Handling Equipment

Adapted for Power House Work

OUR LABRIDE Equipment is comprised of a moving bridge traveling lengthwise of the storage space and a bucket carrier traveling crosswise, similar in all respects to the movement of a traveling crane—thus every square foot of the storage space is covered with a minimum of movements and time, the most correct and economical method known in coal handling to-day.

The Outstanding Advantages of this Equipment are:—

1st—Economy. With the use of this bridge you can save 70% to 95% of your coal handling cost if you are unloading by hand, or 25% to 50% if you are now using other mechanical methods of handling. The saving per ton is greater the more coal you store.

2nd—Eliminates shut-downs due to strikes at the mines or on the railroads or from failure to receive regular commitments of coal due to transportation congestion with which we are all familiar in recent years and which generally occurs just at the time when it handicaps us the most.

3rd—Saving money by enabling you to lay in your supply of coal in the spring and summer months when coal is generally cheaper than it is in fall. This item runs into quite an amount in case of large coal users.

Coal can be unloaded from cars to the bunkers or to the storage pile. Our No. 2 bridge, shown in the illustration above, is electrically operated throughout and has a guaranteed capacity of 60 to 90 tons per hour. The cost of the electrical current is about 60c per hour, depending, of course, upon local electrical rates. The entire unloading operation is handled by two men,—one man in the cab and the other in the car cleaning out the corners.

Write us, giving the layout of your storage yard, and we will be pleased to send a sketch of the equipment adapted to your particular requirements, together with quotation.

LAKESIDE BRIDGE & STEEL COMPANY

159 Villard Ave. North Milwaukee, Wis.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

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THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

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TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

EMPLOYMENT DESIRED

MECHANICAL ENGINEER, 29, FIRST-CLASS stationary engineer's license for Ontario, 10 years' power plant experience, saw-mill and paper mill; specialist in making repairs and operating plant economically, desires permanent position with large saw-mill or paper mill, preferably in New Ontario. Apply to Box 202, Power House. (pfh)

CLOSING TIME

Advertisements for our Classified Section must be in our hands by the 1st and 15th of each month.

In order that the announcements of your wants, Power House Equipment, Employment Wanted, etc., etc., shall not be delayed, please try to have them in our hands by the above dates.

Power House

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Chimney Repair Work

Does your chimney need repairing Experienced chimney foreman an expert repair man is open for en gagements. Put your problems up t me. Rates reasonable.

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For Sale

A number of 100, 150, 200 and 300 H.P. engines of massive construction, ex tanks, etc., not aero engines, absolutely brand new, in crates suitable for tractors, small vessels, pumps, lighting, winding engines, driving auxiliary machinery, etc. These engines are complete and were built for heavy duty Government use by Daimlers, Gardners Hornsby, Brotherhood, etc. Prices from £200 F.O.B. English port. Spares for all parts in stock. These engines must be sold and a large reduction would be made for quantities. Cable for particulars.

Tom Taylor

Marine Engineer, Staines, England

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Special Castings *Forgings*

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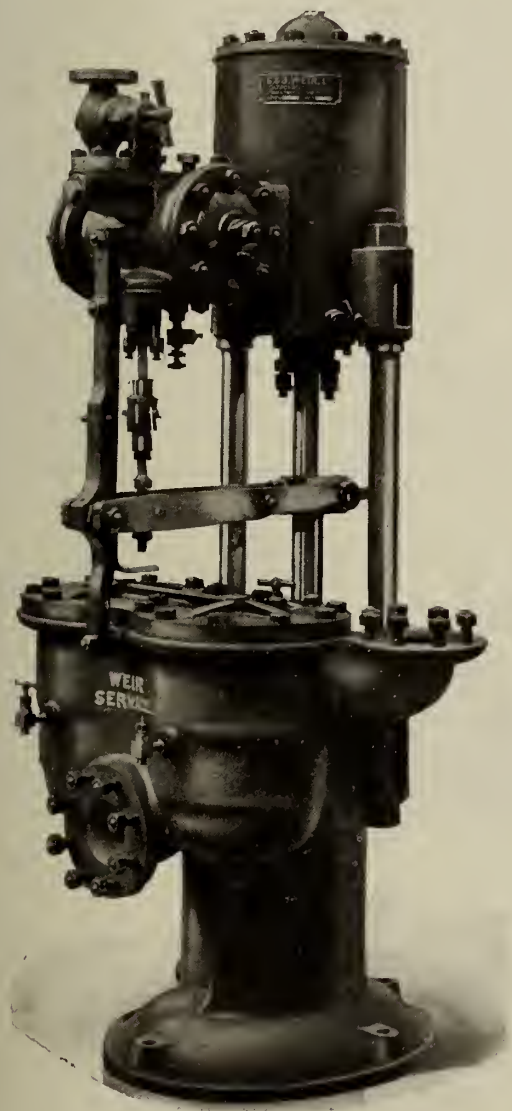

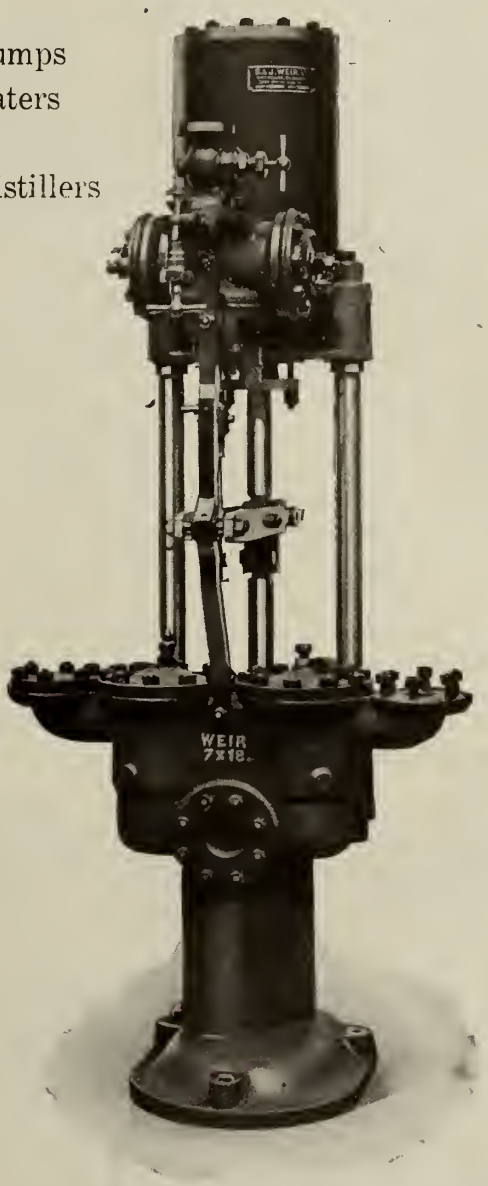

To offer our customers at a fair price the best power plant auxiliaries we are able to make; to ship every order promptly and carefully; to serve our customers in all things to the best of our ability—this is the Weir idea of service.

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PEACOCK BROTHERS, Limited, MONTREAL

Branch Offices at { Lumsden Building, TORONTO
Pacific Building, VANCOUVER

STRAIGHTENING A ROTOR SHAFT

(Continued from page 37)

its original strength, without any treatment, is shown in actual practice. For instance, the shell plates of every boiler that ever was built are strained past their elastic limit, in rolling to shape when cold, and evidently suffer no harm from it.

Another case is that of cold twisted bars used for reinforcing concrete. This cold twisting involves stressing the bars beyond the elastic limit, and yet tests show that the twisted bar has an elastic limit at least 60 per cent. higher than the original bar, and a tensile strength about 20 per cent. higher. That cold rolled shafting is stronger than the plain shafting is well known, and other like products could be cited which prove that a material stressed only once or twice, to a point between the elastic limit and the breaking point, is no weaker than it originally was, if not indeed stronger.

In Kent's Pocket Book are cited some tests proving the truth of this, and from page 239 of the first edition I copy the following: "The common opinion that straining a metal beyond its elastic limit injures it appears to be untrue. It is not the mere straining of a metal beyond one elastic limit that injures it, but the straining, many times repeated, beyond its two elastic limits."

Finally, then, my opinion is that Mr. Quist handled the job the best way, because he got a true shaft of the original dimensions, and that the internal strains from the bending are not of any importance, if indeed they exist at all.

W. J. O'Leary, electrical engineer, of Montreal, has developed a new type of electrical motor, based on the utilization of harmonic vibrations for the source of power. The weight of the rotor is about one-sixth that in an ordinary motor of the same horsepower, and it is stated that a saving of from 20 to 50 per cent. is effected in current used. The invention has been patented in twenty-six different countries, and it is claimed that it can be applied to any machine requiring power for its operation.

Will Extend Plant.—Plans are under way for extensions to the John Inglis Co. plant, Toronto. Wm. Inglis, speaking to a representative of this paper this week, said the biggest part of their business at the present time was repair work, which showed that many firms are in need of new equipment. Mr. Inglis felt that an adjustment of the wage question and a restoration of the public confidence in the matter of steel and other raw materials would go far toward re-establishing business on a firmer basis. His organization is spending $75,000 on improvements for their machine shop, boiler room, foundry and on the plant generally. This, said Mr. Inglis, shows what faith they have in the future. Mr. Inglis said they had been negotiating for some time for the purchase from the city of some land directly across the road from their present site, and that he hoped to be in a position to close this deal and proceed with the building of a new foundry without further delay. Mr. Inglis left the city on Friday on a business trip to Chicago.

An incorporated company to be known as the Prince Edward Island Light, Heat and Power Co. has recently been formed to supply light, heat and power by the use of electricity to all parts of Prince Edward Island, from one large central power station, using coal for generating purposes. It is expected that permanent employment will be provided for about 200 men. Noah A. Timmins, multi-millionaire, and W. J. O'Leary, electrical engineer, both of Montreal, are interested in the company.

E. McG. Quirk, of the Federal Labor Department, is now in Cape Breton district on behalf of the Dominion Government for the purpose of investigating conditions relating to the steel industry. The primary reason for this move is the request of the steel workers for a general inquiry into the situation existing in that section, particularly in connection with the recent wage reductions made by the steel companies.

Engineers' A.B.C. Register

(A Free Service)

POWER HOUSE maintains a Register of qualified engineers which manufacturers may consult and to which we may refer when our advice is requested.

Subscribers are invited to give their name, age, grade, experience, salary and all other information which they think advisable.

Our A.B.C. Register is a free service which engineers and manufacturers do well to avail themselves of.

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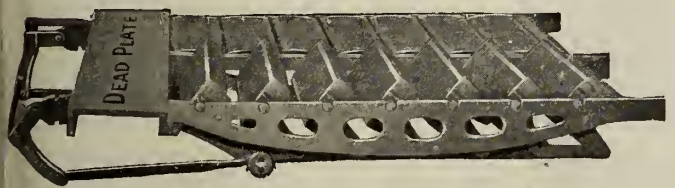
GRATES



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Extravagance Must Stop!

THE COPES
Boiler Feed
REGULATOR

is a vital organ in the system which draws the latent energy out of the coal pile and delivers it at the bus bar or the main drive shaft.

Without the Copes Boiler Feed Regulator none of the other organs can perform its function properly. Stokers, feed water heaters, water softeners, and the boilers themselves cannot do their best without proper feed water regulation. The legibility of steam and water flow records, pressure and temperature charts, all depend more or less on scientific feed water regulation.

For complete information about COPES BOILER FEED REGULATORS, ask for Bulletin D.

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The World's Largest Manufactures of Feed Water Regulators

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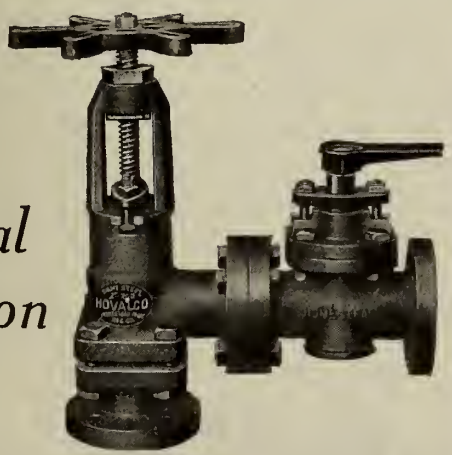
V. W. HICKS & CO., 567 Banning St., Winnipeg, Canada.

108

A Safe, Economical Combination



An absolutely reliable combination, consisting of the "Hovalco" Blow-off Valve and the "Homestead" Quarter-Turn Valve.

It puts an end to all blow-off troubles. Nothing can pass when both valves are closed. Gives a clear, straight-way passage when open—no tendency to clog with scale.

Write for full description.

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Ten hours! More than a day's labor! Think of the cost in dollars!

Such was the result of a test between the flexible type of hack saw and an all-hard blade,

Both were designed to cut the same material! Both were carefully run to deliver the utmost service, but the all-hard blade demonstrated from the start that it cut costs by cutting quicker. On power sawing, where weight is needed to make the teeth of a blade "bite" into the stock, the soft-back saw is not practical. Because of its flexibility, pressure makes it "buckle" Without this weight the cost per cut is too high.

For economical power sawing the proper blade for the particular kind of material to be cut is indicated by the Starrett Hacksaw Chart. It will be mailed to you, free.

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A Republic Will Reduce the Size of Your Ash Pile

Ash Pile of Plant Without Co_2 Equipment

Ash Pile of Republic Equipped Plant

A certain well-known plant noticed that with the installation of Republic CO_2 Recorders the quantity of ashes became materially reduced. The logical, and in fact the only deduction was that they were **burning less coal.** And this is Republic Operation "in a nutshell."

Install a Republic and you too will notice the gradual diminishing of your ash pile. You will see your firemen vieing with one another to make their charts "show high" and pointing with pride to records of successful accomplishment. And this represents to you a coal and money-saving that may become even greater by the probable disclosing of unknown wastes in power manufacture.

So simple, accurate and strong is the Republic Equipment that it must appeal to every hard-headed business executive. Consider these features:

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The pen is adjusted so that the operator can easily see the last record.

The records actually **keep pace** with the furnace.

The entire instrument is complete in an easily-adjustable case weighing only 45 pounds.

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NO DELICATE PARTS

Republic CO_2 RECORDERS

CONVENIENT SIZE
SIMPLE MIXTURES
ACCURATE RECORDS

Let us tell you more about the advantages of Republic CO2 Equipment. Our catalogue contains the facts. Write for a copy.

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ENGINEERS, power plant managers, executives in all lines of industry profit by the Worthington policy of building every type in each of its lines of equipment.

Worthington equipment is to be found in every industry, every country that measures machine value by the quality of work done. In power plant service for instance, machinery designed and built by the Worthington Pump and Machinery Corporation has satisfied over 200,000,000 boiler horse power. The period of service extends through eighty-one years—since 1840.

The policy of manufacturing every type of given equipment assures the buyer of impartial advice on his selection and is applied to all lines of Worthington equipment from the small domestic sized water meter to huge oil engines.

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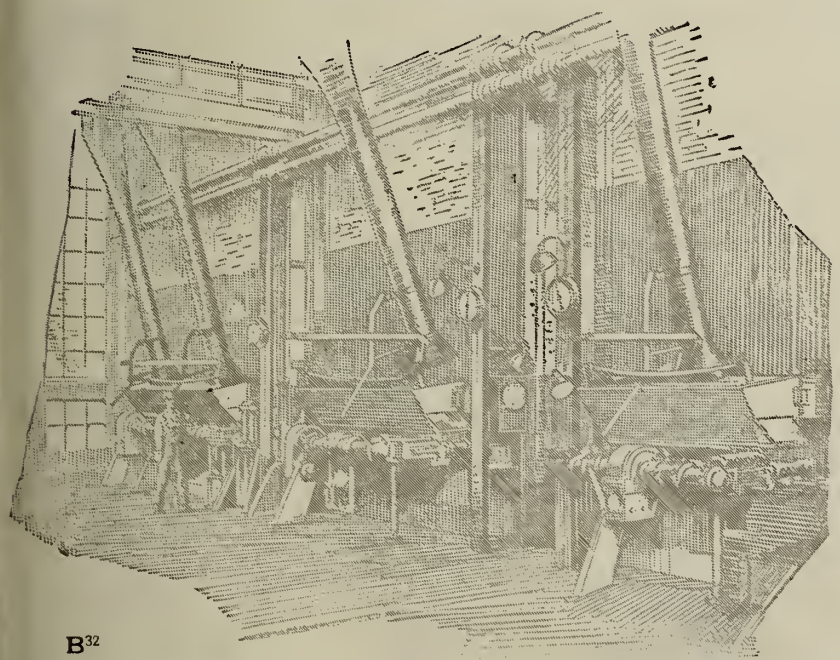

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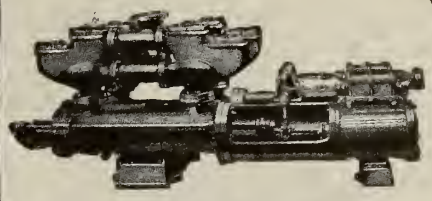
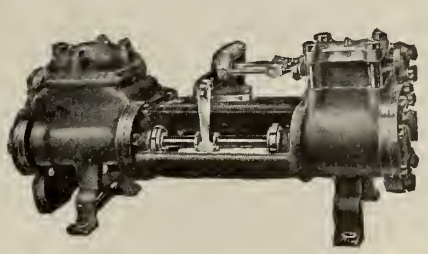
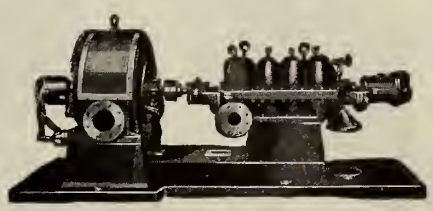


Pot Valve Boiler Feed Pump



Duplex Packed Piston Pump



Multistage Centrifugal Pump
Boiler Feed Pattern

Open Feed Water Heater
"Stilwell" Type

Combines in one unit a Feed Water Heater, a Feed Water Purifier, a Condensate Receiver and a Feed Water Softener. Marked economies and increase in boiler capacity follow its installation in steam plants.

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They are subjected to an air-under-water test of 300 pounds.

Constant analyses and tests are made to insure uniformity of product.

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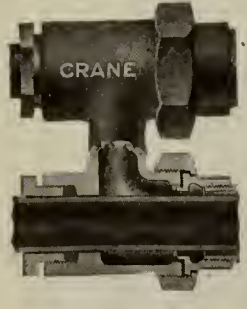

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Stirling Type Boilers CLEAN

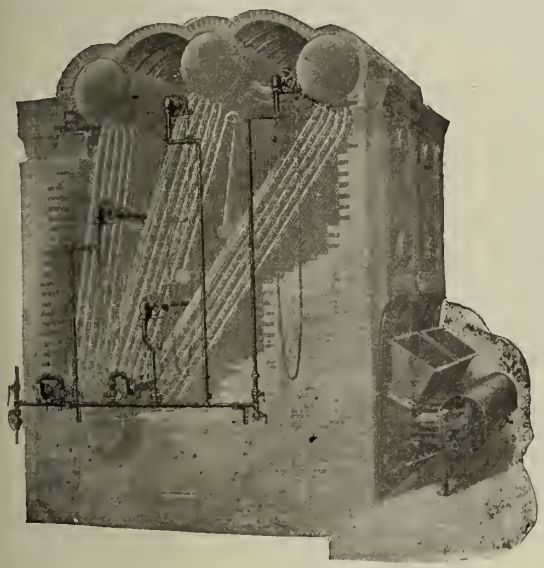

Illustration of the Vulcan Soot Cleaner installed in a boiler of the steep tube type, such as Stirling, Badenhausen, Connelly, and Erie City Vertical.

The Standard boiler usually requires a six-element System; an additional element when a superheater is used; and a five-element System when the boiler is of the low type, and narrow width.

T is important, in considering soot cleaning equipment, to appreciate the cessity for THOROUGH EANING. For without at, the mechanical soot aner is worse than use-ss.

The soot problem in the eep Tube Type boiler cen-es very largely in the first ss. It is vitally essential, erefore, that this pass be oroughly cleaned; although, course, it is almost equally al that the other passes be aned as well.

Vulcan Soot Cleaners have en notably successful in aning boilers of the Steep be, or STIRLING, Type, e principally to the stra-gic locations of their clean-g elements in the first pass. e above illustration shows element located at the top the first tube bank, just below the drum. Another element is located at the bottom, between the first and second tube banks, and is ingeniously protected against the hot gases. Both of these elements have a clean sweep up and down the first bank of tubes—and, because of the Vulcan method of blowing BETWEEN THE TUBES, NEVER AGAINST THEM, the sweep is equally clean straight through each row to the last. The remaining passes are cleaned in the same manner.

If you are considering soot cleaners for your boilers, of whatever type, let us send you our folder "SPENDING $796 TO EARN $1,017.40," giving an interesting financial analysis showing the dividend-paying value of Vulcan Soot Cleaners. Address any of our offices—there is no obligation whatever.

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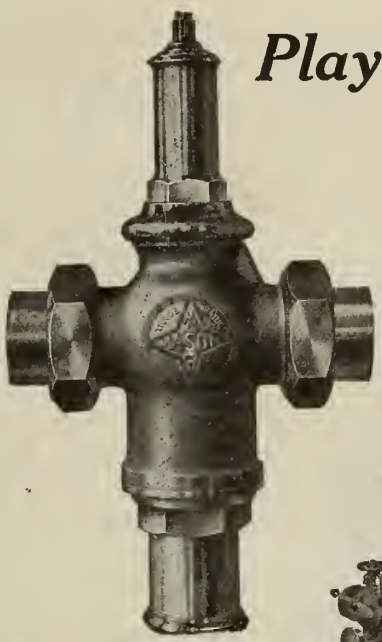
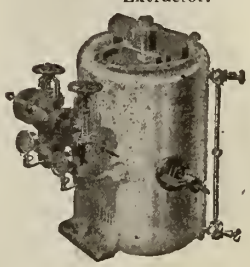


Mason Standard Bronze Reducing Valve.

Reilly Feed Water Filter and Grease Extractor.



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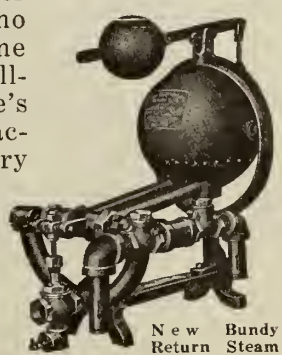
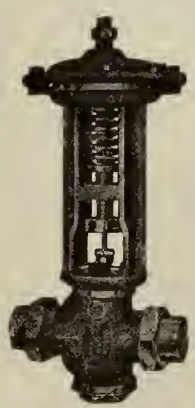
are the right kind of devices for the Power Plant Engineer who "plays safe." When he chooses any of the well-known Mason lines he's as certain of satisfactory, free-from-worry service as if a gilt-edged coupon were placed in his hand. Mason Equipment has brought satisfaction to hundreds of Power Plants.



New Bundy Return Steam Trap.



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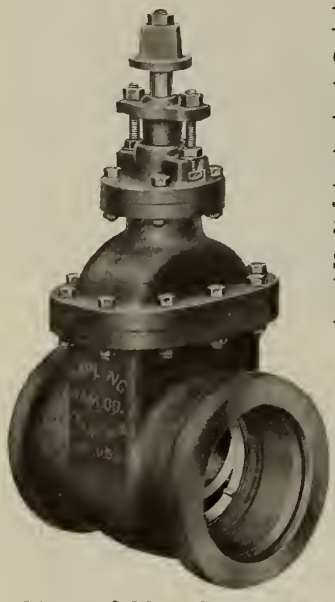

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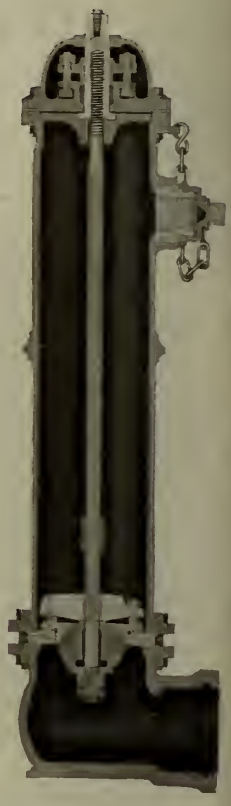

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KEEP YOUR BOILERS CLEAN

TO SAVE FUEL

1/8-inch Deposit on Tubes Increases Coal Consumption 30%
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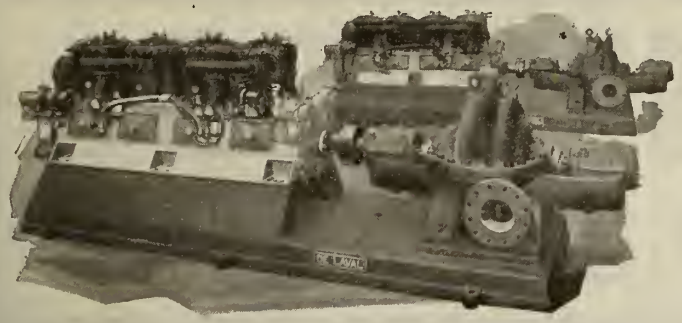

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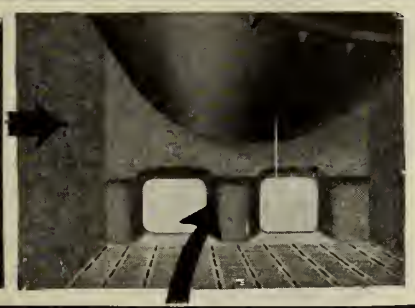

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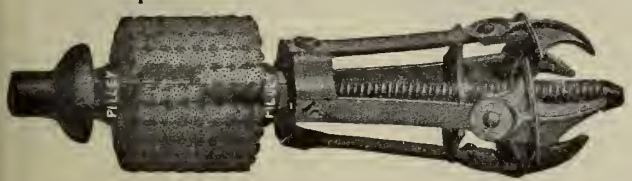

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For sale by leading Canadian jobbers.
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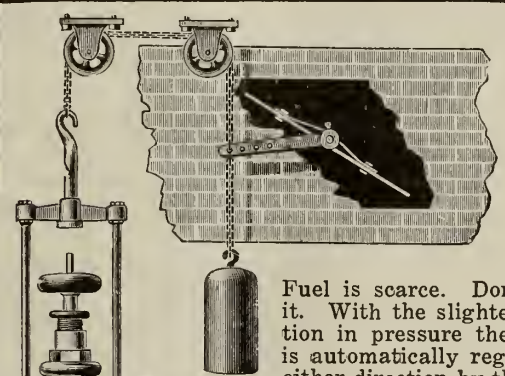

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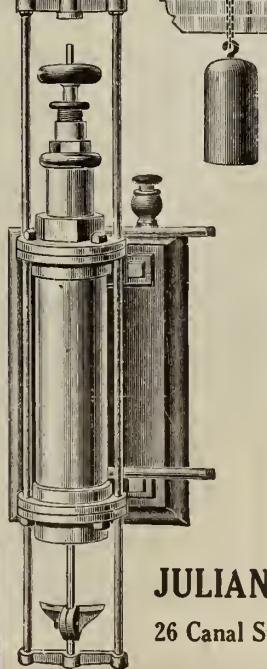

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Frank S. Cahill, M.P.—keenest critic in the House of Commons of the Government in railway matters—has written for April 15th MACLEAN'S a striking article, in which he calls for the handing over of the railways to a private corporation—*to run properly.*

Also, in another striking article a prominent, nationally-famous, business man calls for the appointment of a commission of railway experts—probably (so that they may be unbiased) selected in the U.S. After a searching investigation, he advocates that:

1—Certain lines be leased to the C.P.R.;
2—Non-paying lines cut off;
3—Remaining lines handed over, on equitable basis, to private company.

What do business men think of the parliamentary committee appointed to investigate railway conditions? — "Political probe? Pah!—a bunch of amateurs!"

Review of Reviews

Squandering Uncle Sam's Billions Paul V. Collins
German Industry Recovering Lindsay Bashford
London Journalistic School Founded Lord Northcliffe
"Law-and-Order"—Coolidge Arthur C. Brooks
Rubber Substitute Discovered Pan-American Magazine
Northcliffe's Bathtub Interview Roger Lewis
African Buffalo a Fighter Charles E. Akeley
Suggested Capital-Labor Solution James Kidd
Some Queer Clubs ..... Sunday Express
Sugar From Pumpkins ..... J. N. Bishop
Present Conditions in Roumania Charles Woods
What Is Education? .....Alexander Irvine
Germany, Shakespeare and Bacon London Times
Auction Bridge for Two A. E. Manning Foster
X-Ray Movies ... Prof. Harold E. Richards
A Vital Factor of Success .Lord Beaverbrook
Should Britain Abandon Mesopotamia? Ikbal Ali Shah
What Should Germany Pay? Bernard M. Baruch

—also

Articles -- news and feature

"GIVING AWAY OUR PROFITS"—
By Agnes C. Laut.
A strong plea for Canadians to make the most of their raw product assets,—particularly pulp and fur.

"OIL IN THE SPLENDID SIXTIES"—
By Victor Lauriston.
The romantic story of the oil boom in Western Ontario half a century ago.

"OUR AUTHORS GET TOGETHER"—
By Arthur Stringer.
Union of Canadian pen-pushers and type-writer-tappers is formed in Montreal—what it means to our Country.

"THE MORAL HAZARD"—
By Guy Morton.
What happens in Spring if you insure your flivver at the valuation of a Rolls-Royce.

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Even greater economies, however, are open in the thousands of plants where reciprocating engines operate, because these engines actually benefit to a greater degree by superheated steam than do steam turbines.

An idea of the relative economies of superheated steam is disclosed in the following table. By reducing steam consumption, superheated steam saves fuel.

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Simple non-condensing automatic	26-40	18-34	16-30
Simple non-condensing Corliss	26-35	18-30	
Compound non-condensing .	19-28	15-25	13-22
Compound condensing	12-22	10-20	9-17
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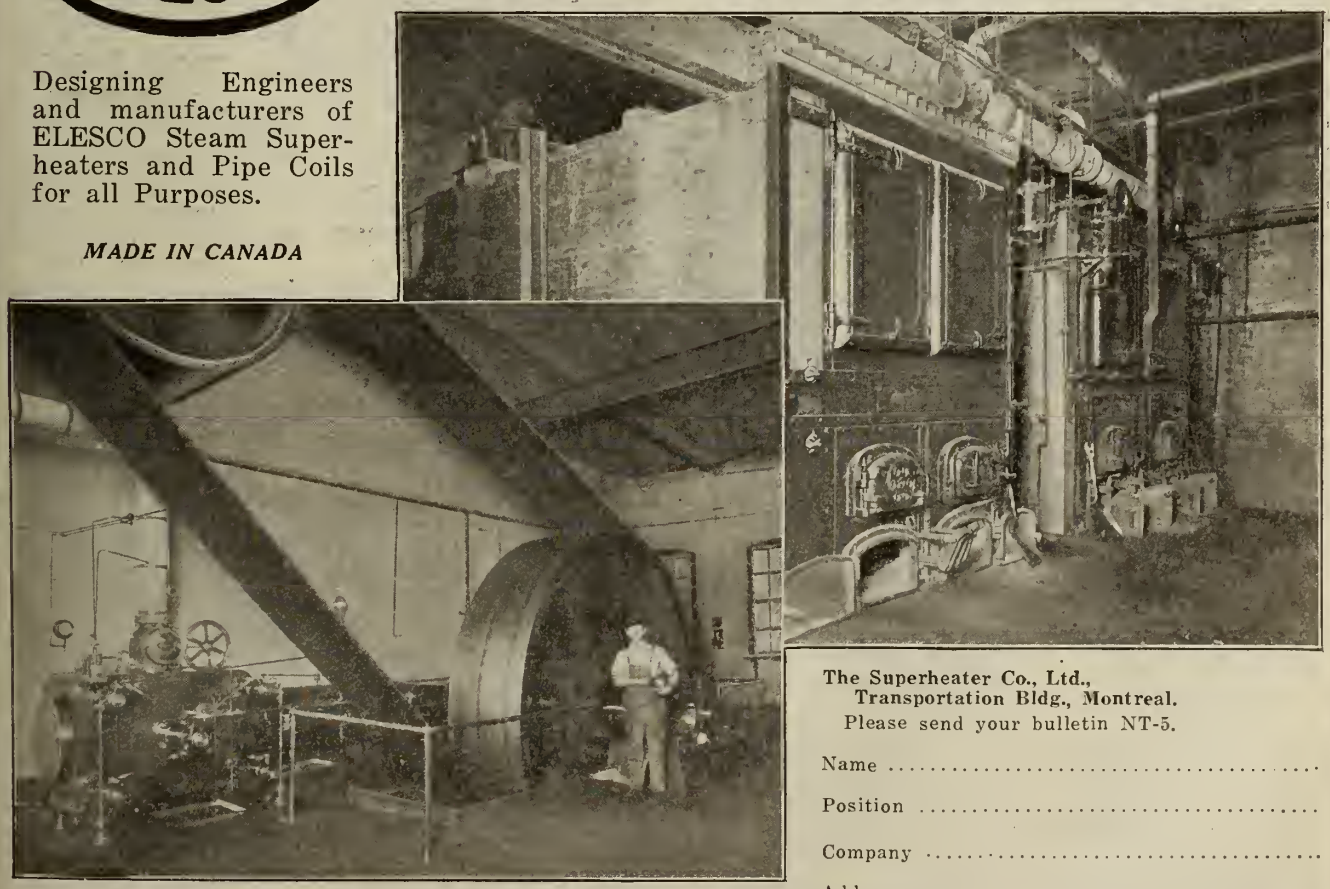

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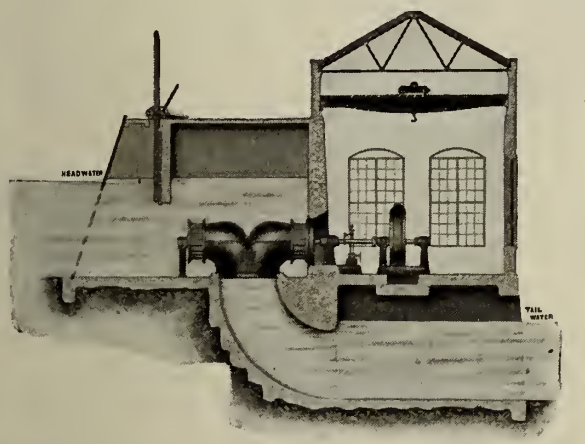

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FITTINGS
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FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Republic Flow Meter Co. of Can., Toronto.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Filley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Uehling Instrument Co., New York.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp. Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., L.
Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.,
Linde Can. Refrigeration Co., Montr.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—A TYPES
Uehling Instrument Co., New York,

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Mont
Can. H. W. Johns-Manville Co., Toro
Green's Economiser, Ltd., Toronto,
Uehling Instrument Co., New York,

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto
Penberthy Injector Co., Windsor, On

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto,
Taylor Instrument Co's., Rochester,
Yarnall-Waring Co., Philadelphia,

INSULATING BRICK
Armstrong Cork & Insulation Co.,
treal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toro

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn

IRON FILLER
Can. H. W. Johns-Manville Co., Toro

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, On

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, On
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toro
D. K. MacLaren, Ltd., Montreal, Q

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Mont
Can. H. W. Johns-Manville Co., Toro

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Mont
Can. H. W. Johns-Manville Co., Toro

LEATHER BELTING
W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STRE
Northern Electric Co., Ltd., Montreal

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEE STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, On
Jas. Morrison Brass Mfg. Co., Toronto

LUBRICATING OIL FILTER AND CIRCULATING SYSTE
F. Bowser Co., Ltd., Toronto, On

LUBRICATING OIL STORAG SYSTEMS
S. F. Bowser Co., Ltd., Toronto, On

LUBRICATORS, CYLINDER C TING COMPOUNDS
Penberthy Injector Co., Windsor, O

LUBRICATING OIL STORAG TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, On

LUBRICATORS, FORCE FEE
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que
Penberthy Injector Co., Windsor, O

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, O

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, O
Armstrong Cork & Insulation Co.,

MACHINERY, MINING (CO PRESSORS)
Holden Co., Limited, The, Montreal.

MACHINERY, TRANSMISSIO (POWER)
Can. Mead-Morrison Co., Ltd., Mont

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLA
Can. Mead-Morrison Co., Ltd., Mont

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester,

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

We make Boilers—all Types—Plate Work—Pulp Mill Machinery, etc.

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Canadians are a nation of workers—

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We have to-day the largest per capita purchasing power of any nation in the world—

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METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

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Jas. Morrison Brass Mfg. Co., Toronto.

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OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

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Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
W. J. Brown (Tucks), Montreal.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

PACKING, ENGINE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Beldam Asbestos (Canada) Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Beldam Asbestos (Canada) Co., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ort.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

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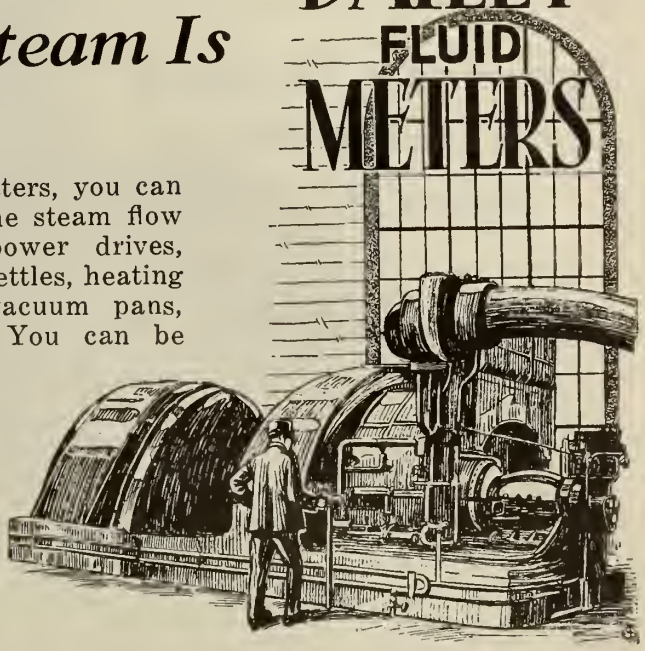

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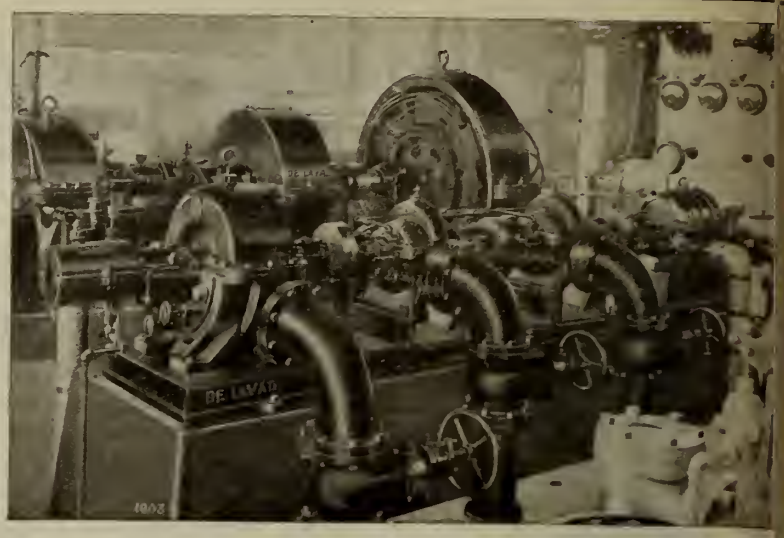

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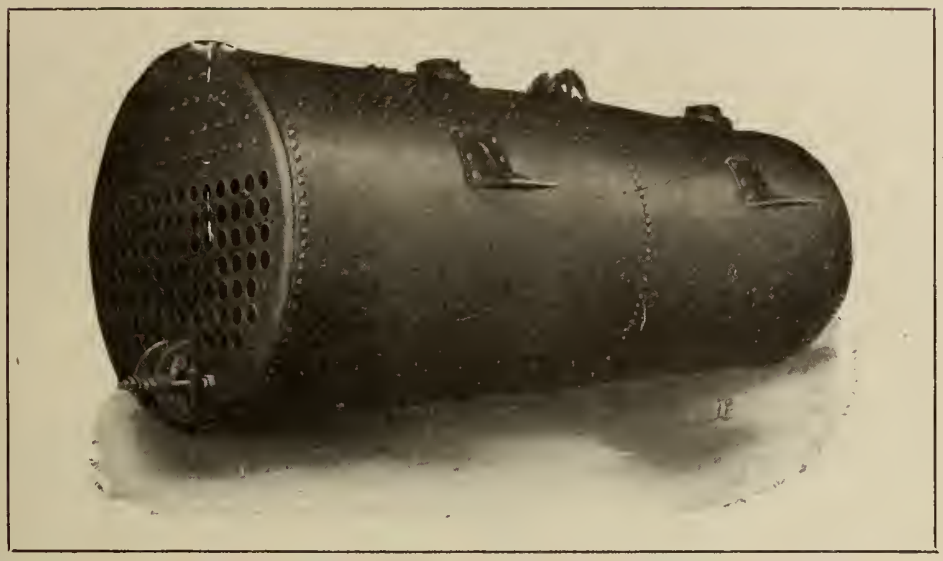

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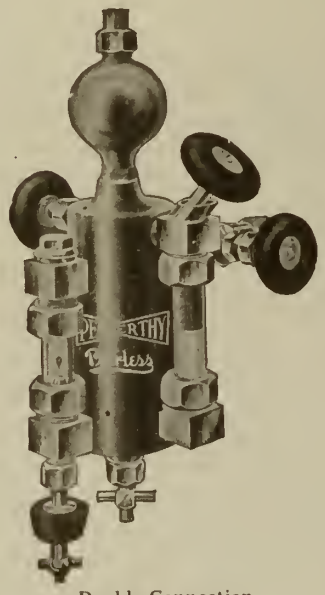

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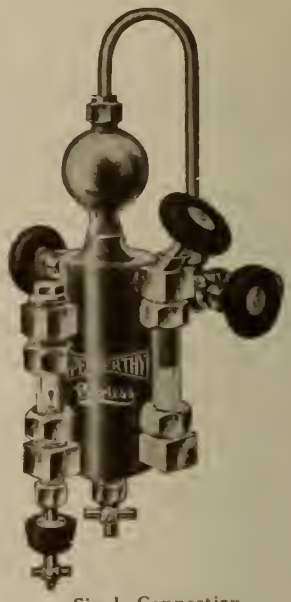

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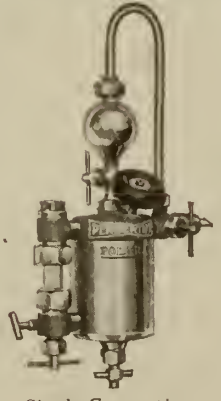

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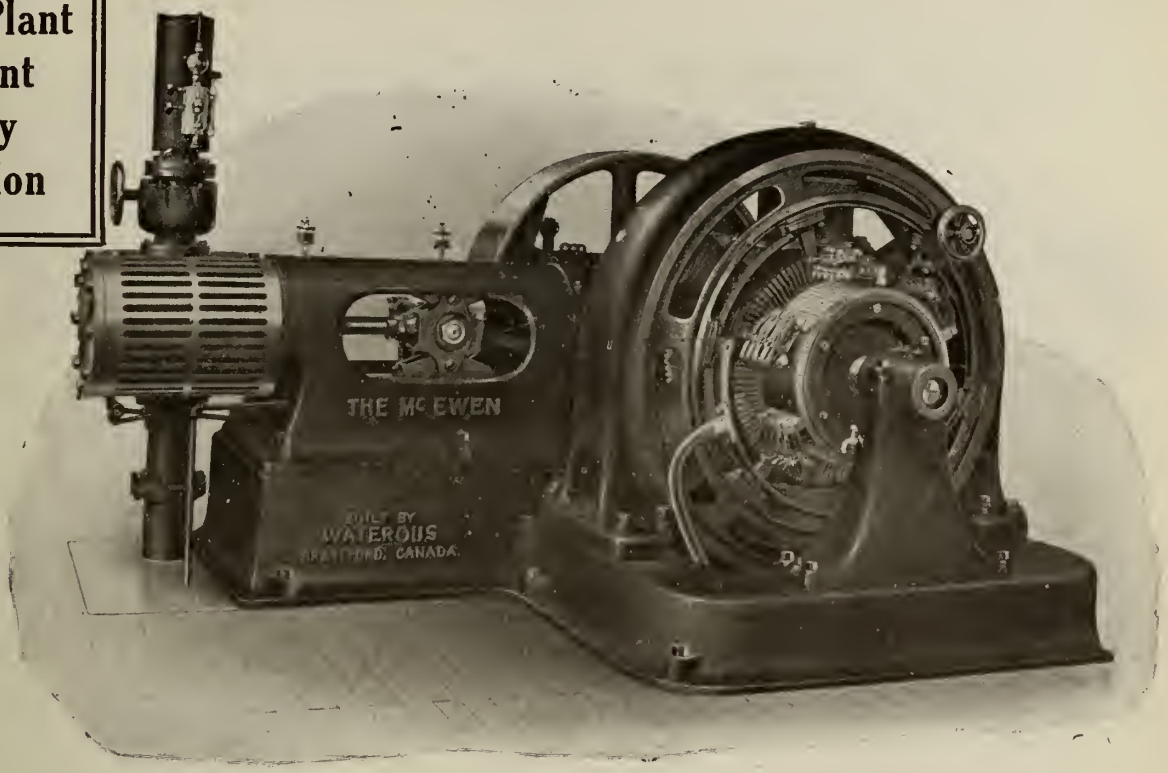

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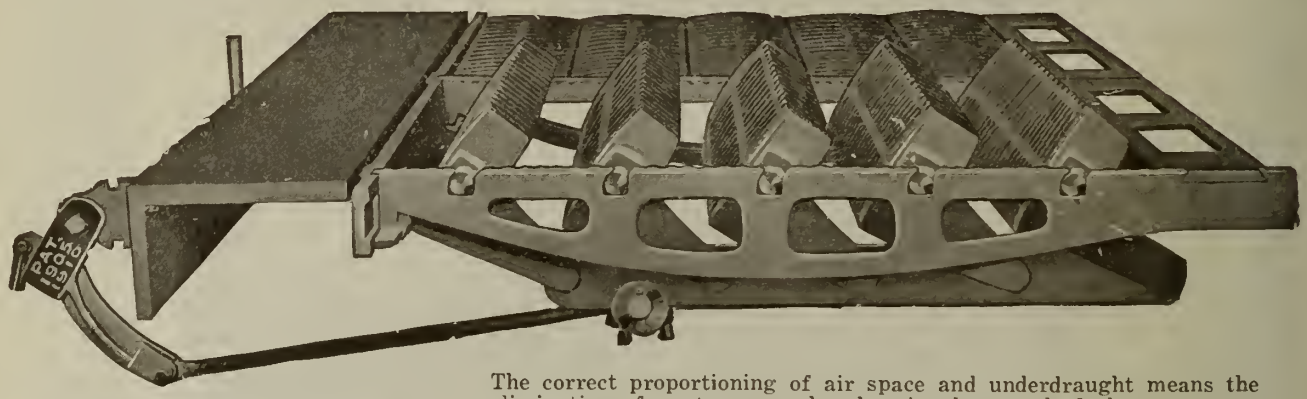

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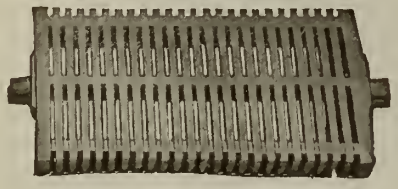

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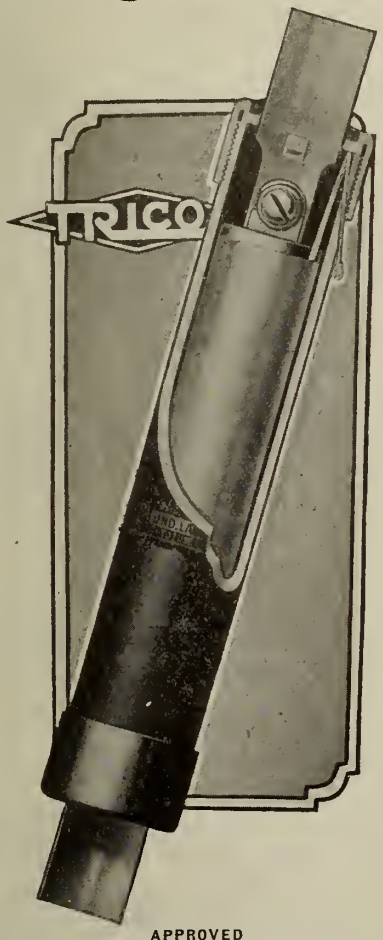

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New Truths and Old Fallacies

Hardness of Alloys—*Continued*

These figures in preceding article of compression tests show that formulas Nos. 1 and 2—tin base metals—containing respectively 4½ per cent. and 3½ per cent. of copper, were less distorted under compression than formula No. 3, which contained 8 1-3 per cent. copper and also a greater percentage of antimony than Nos. 1 and 2.

Equally strange is it that formula No. 4, containing only 3 per cent. copper and 10 per cent. lead give better results than No. 3. Again all rules were apparently upset by the showing of the lead base formulas, containing no copper, and in some cases no tin.

But this carries out, to some extent, the statement made by Charpy, that the eutectic is the limit of the strength of an alloy.

Antimony has the most pronounced effect in hardening an alloy, but at around 18 per cent. antimony and beyond the alloy becomes very brittle, thereby losing any value of malleability. For this reason the antimony content of alloys is kept within certain bounds and tin is added to give additional hardness, without impairing malleability and in this way the equilibrium of an alloy is maintained.

If tin in a lead base alloy has any other advantage, we do not know it, and its use beyond a comparatively small percentage lowers the fusibility.

If copper is also added to a lead base metal it still further increases fusibility and also comes to the surface in the form of "creepers," makes the mixture dirty looking and sluggish in pouring and when heated cupreous gases sometimes form and produce blow holes.

(Continued next month).

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"New Truths and Old Fallacies"

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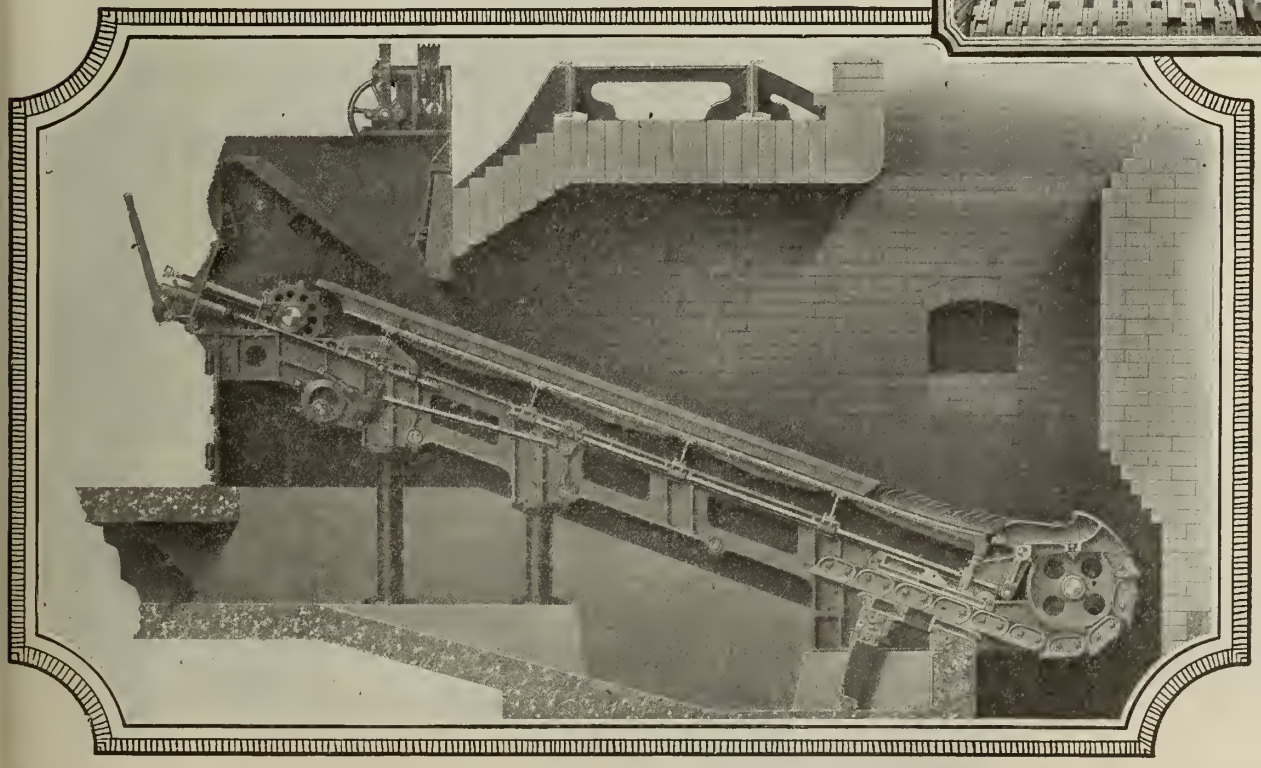

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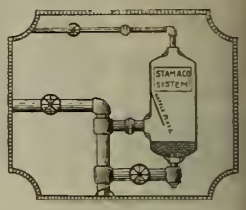


Blow-down of boilers is considered a big loss.

Stamaco eliminates blowing down, thereby creates a saving.

Do you realize that every time your engineer blows down your boiler, that 8% to 12% of fuel is wasted.

Stamaco is guaranteed to save fuel and labor and keep your boiler automatically and continuously clean.

Further details on application.

Sales Agents for Plibrico Jointless Firebrick

STAMACO
THE
SYSTEM
THAT
SAVES

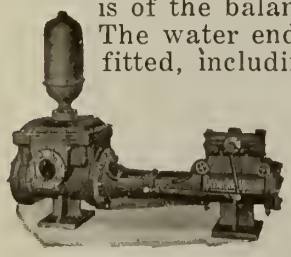
Mill Supply Dept.
Beveridge Paper Co.
LIMITED
MONTREAL

AMERICAN-MARSH PUMPS

SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—
Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

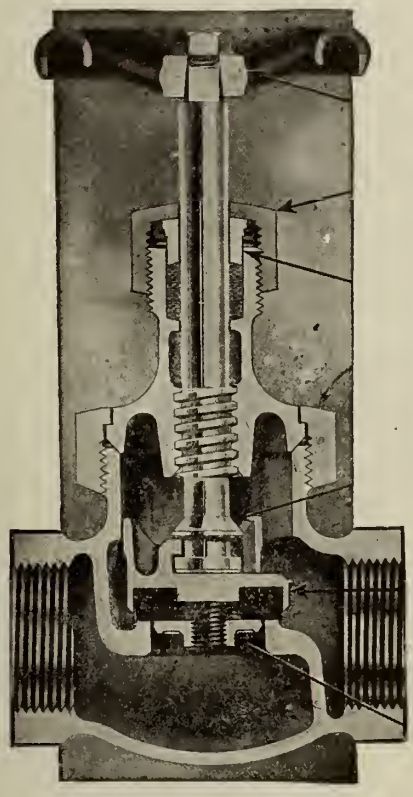
Ask for General Catalog

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London, Ont. Gorman, Clancy & Grindley, Limited, Edmonton. Calgary and Vancouver.

SEVEN FEATURES OF THE CRANE NUMBER 7

for use in plants where continuous service is required and where discs must be changed quickly without injury to the valve.



1—Easily removable malleable iron, non-heat wheel

2—Malleable iron nut

3—Brass gland

4—Malleable iron nut

5—May be packed under pressure when valve is wide open

6—Removable disc holder for quick change

7—Removable nut for changing disc

Made in sizes ¼-to 2-inch; for 150 pounds steam working pressure; discs for steam, air and water supplied as ordered. Body, Bonnet, Stem, Disc Holder, Gland, made of Brass.

Fully described in Circular No. 1 which will be sent upon request.

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

CRANE LIMITED
HEAD OFFICE & WORKS
1280 ST PATRICK STREET
MONTREAL

Branches and Warehouses:
HALIFAX, OTTAWA, TORONTO, WINNIPEG, REGINA, CALGARY, VANCOUVER.

Sales Offices:
QUEBEC, SHERBROOKE, HAMILTON, VICTORIA.

CRANE-BENNETT Limited
Head Office and Warehouse:
LONDON, ENGLAND.

Sales Offices:
MANCHESTER, BIRMINGHAM.

8

GARLOCK PACKINGS

BETWEEN THE COAL PILE AND THE ENGINE

At this time more than any time in the history of engineering, highest efficiency is demanded. A blown out gasket can shut down a plant just as surely as a broken piston rod. Every leaking manhole joint or pipe flange represents a distinct loss, and it has been demonstrated by scientific experiment that there is no limit to the loss caused by undue friction on piston rod and valve stem packed with an inferior packing, and the constant use of a wrench in attempting to stop leaks at rod glands. Let Garlock No. 950 Gasket, cut from No. 900 Sheet Packing, reduce the loss between coal pile and engine.

THE GARLOCK PACKING CO.
HAMILTON, ONT.

SPARE THE ROD

Building a one-piece furnace lining without special or tools—No separate brick and no clay mortar joints.

While Business is Slow

Install New Boiler Furnace Linings and Baffles

Now, is the ideal time to re-line your boiler furnace, or put in new sloping baffles. Then you will avoid annoying delays and loss of time later on.

Permanent One-piece Linings and Baffles of

BETSON'S PLASTIC FIRE BRICK

are easily installed without special forms or tools, even with inexperienced help.

The high temperatures reached by modern boiler furnaces, cause rapid disintegration of clay mortar joints, followed by complete destruction of the fire brick linings, arches, etc.

A solid one-piece lining, including front and back arches, side walls and baffles, costs but little to install in any make or type of boiler, and saves fuel, annoying shut-downs, costly repairs, and increases the amount of usable power from the fuel you pay for.

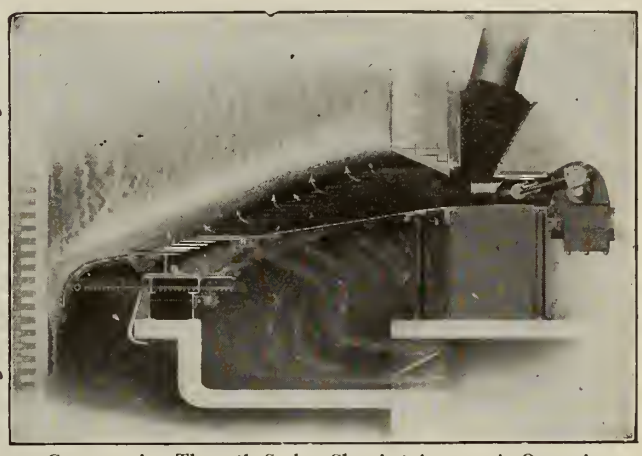
Complete details of the uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N. Y.

Canadian Distributors:
INTERNATIONAL CHEMICAL CO.
44-6 Lombard St., Toronto, Ont., Canada

"If it isn't Betson's, it isn't Plastic Fire Brick"

BURN ALL GRADES OF COAL



Cross-section Through Stoker Showing Automatic Operation

No device has shown itself better adapted to burn any available coal than

RILEY UNDERFEED STOKERS

Low-grade coals—those high in ash—in sulphur and clinker-forming qualities—can be handled successfully for the following reasons:

1. The moving grates keep the clinkers broken up—combustion is intensified—the fuel bed is always active, even and in a homogeneous state.

2. The rocker dump, with its combination of vertical thrust and rocking motion, grinds up—discharges the ash continuously and automatically—keeps the fire clean and the bridge wall free from accumulations.

3. The underfeed feature makes possible high capacity and instant response to overload demands.

Our engineers will be glad to acquaint you with the wide range of fuels now being handled by the RILEY UNDERFEED STOKER under many varying conditions.

Write for Catalog HR 5

Sanford Riley Stoker Company
Worcester, Mass.

LINDE

Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

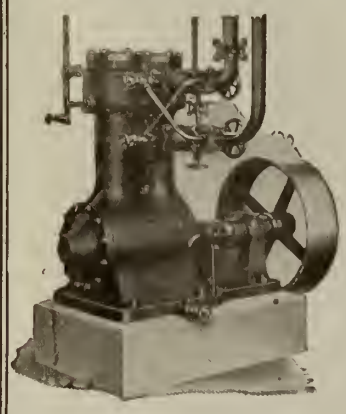
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

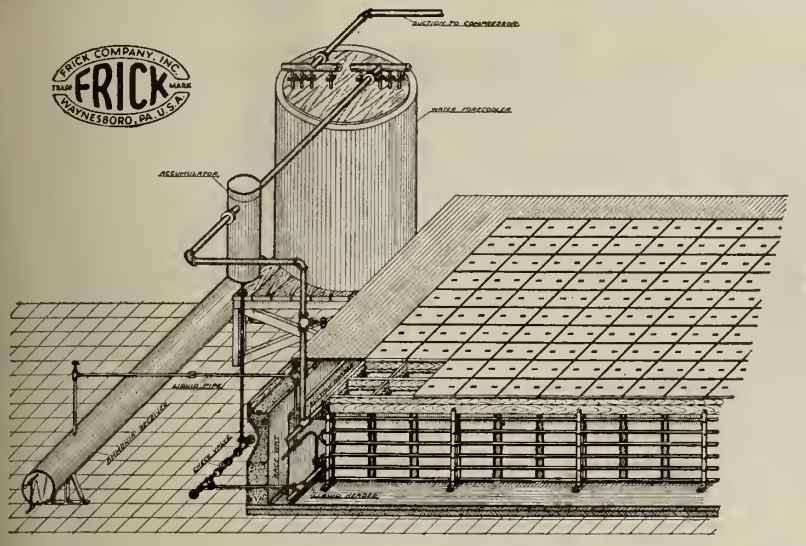
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



The FRICK FLOODED SYSTEM

Is a STANDARD Part of every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

- Simplifies plant operation by reducing the number of feed valves to be regulated.
- Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
- Adds to plant safety by preventing priming accidents.
- Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

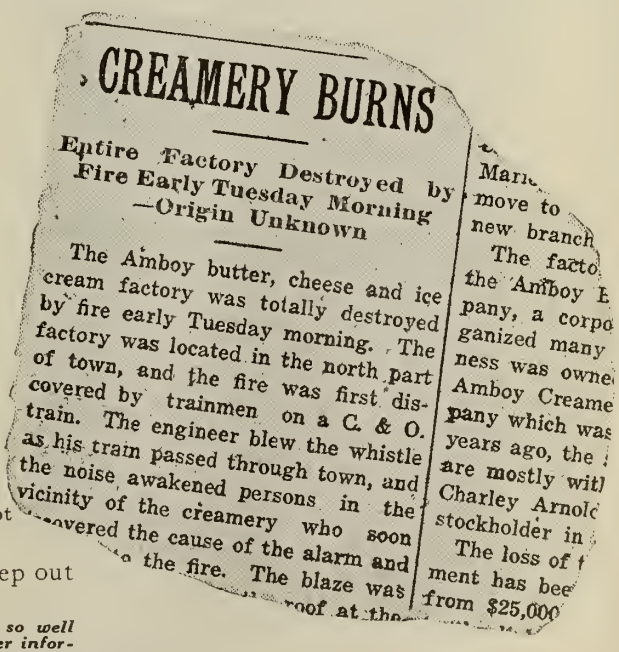
A Test We Didn't Make

Maybe you are one of those who are a little skeptical about manufacturers' tests on insulating material. All right—here is one there can be no question about. Not even the customer made it. It was made for him, and the making of it destroyed his whole plant except the hardening room. But read this letter from the Amboy (Ind.) Creamery Company, dated January 12, 1921:

> "On the morning of December 21 our entire plant was consumed by fire. Our refrigerating room was inside of the creamery. After the fire the ante room was all burned down, and the hardening room, which was built of two layers of three-inch corkboard, went through the fire without being burned very badly. The outside of the room, which was covered with lumber, was all burnt off and just the cork was left.
>
> "Ten hours after the fire, when we opened the door, the temperature of the room was 10 degrees below freezing. We expected to find the room very hot and that the ice cream would be ruined. The 150 gallons of ice cream was in fine condition; could not tell it had been through a fire.

"We feel that the cork must have been all you said it was or it would not have stood the test it did."

A very satisfying test. Nonpareil Corkboard certainly does keep out the heat.



CREAMERY BURNS

Entire Factory Destroyed by Fire Early Tuesday Morning —Origin Unknown

The Amboy butter, cheese and ice cream factory was totally destroyed by fire early Tuesday morning. The factory was located in the north part of town, and the fire was first discovered by trainmen on a C. & O. train. The engineer blew the whistle as his train passed through town, and the noise awakened persons in the vicinity of the creamery who soon discovered the cause of the alarm and gave the fire. The blaze was

Marie
move to
new branch
The facto
the Amboy E
pany, a corpo
ganized many
ness was owne
Amboy Creame
pany which was
years ago, the
are mostly wit
Charley Arnold
stockholder in
The loss of
ment has bee
from $25,000

Why Nonpareil Corkboard insulates so well and lasts so well and what that means to you is explained along with other information of great value to users of refrigeration in the 152-page book, "Nonpareil Corkboard Insulation." There is no charge for it. A copy of the book and a sample will be sent to you promptly if you will send in your name.

Armstrong Cork & Insulation Company, 902 McGill Bldg., Montreal, Que.; 11 Church St., Toronto, Ont.

Nonpareil Corkboard Insulation

For Ice Cream Hardening Rooms

The York Service Organization

York QUALITY Products and Expert ENGINEERING Advice are brought into close proximity to every user of Ice Making and Refrigerating Machinery by the York Service Organization.

The close, personal touch afforded by this organization in all our dealings with our customers, and the prompt service we are thereby enabled to render, has contributed in no small degree to the Confidence which the Trade places in York QUALITY Products.

Whether you are thinking of installing a new plant, require engineering advice, or need supplies for your Ice Making or Refrigerating Plant, it will pay you to write our nearest Branch.

MECHANICAL QUALITY YORK SERVICE **REFRIGERATION**

The Trade in the Dominion benefits by the ability and experience of this Organization through four regularly established Service Stations.

Canadian Ice Machine Company

TORONTO
Villiers & Munition Sts., Eastern Harbor Terminals

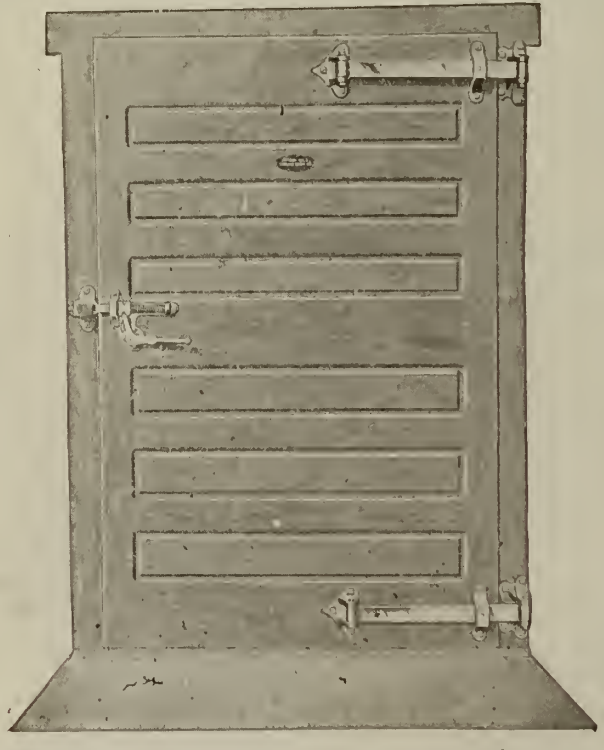
MONTREAL
324 Craig St. West

WINNIPEG
85 Lombard St.

CALGARY
605 Second St.

YORK MANUFACTURING CO., YORK, PA., U.S.A.

(Ice Making and Refrigerating Machinery exclusively)



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.

CO_2 Indicator for boiler front guides the fireman in saving coal

The Big Boiler Room Waste

is the heat discharged up the chimney

UEHLING CO_2 EQUIPMENT

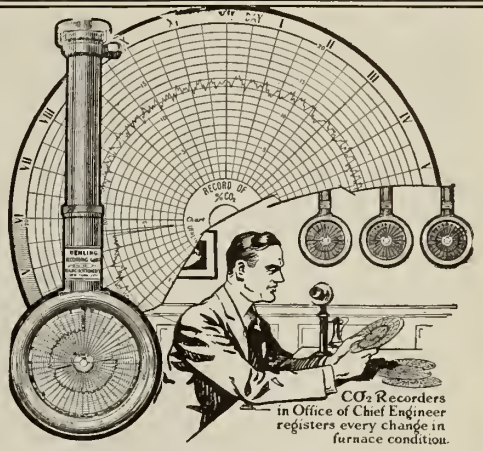
keeps tabs continuously (not intermittently) on this waste, thus enabling engineer and firemen to co-operate in reducing it. Uehling CO2 Equipment is simple in principle and operation and uses no chemical solutions.

Write for New Catalog.

UEHLING INSTRUMENT CO.

Combustion Engineers

2008 Empire Bldg. - New York



CO_2 Recorders in Office of Chief Engineer registers every change in furnace condition.

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings ***Forgings***

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Blueprints for Quotations. Write for our latest catalogue.

Patterns ***Machine Work***

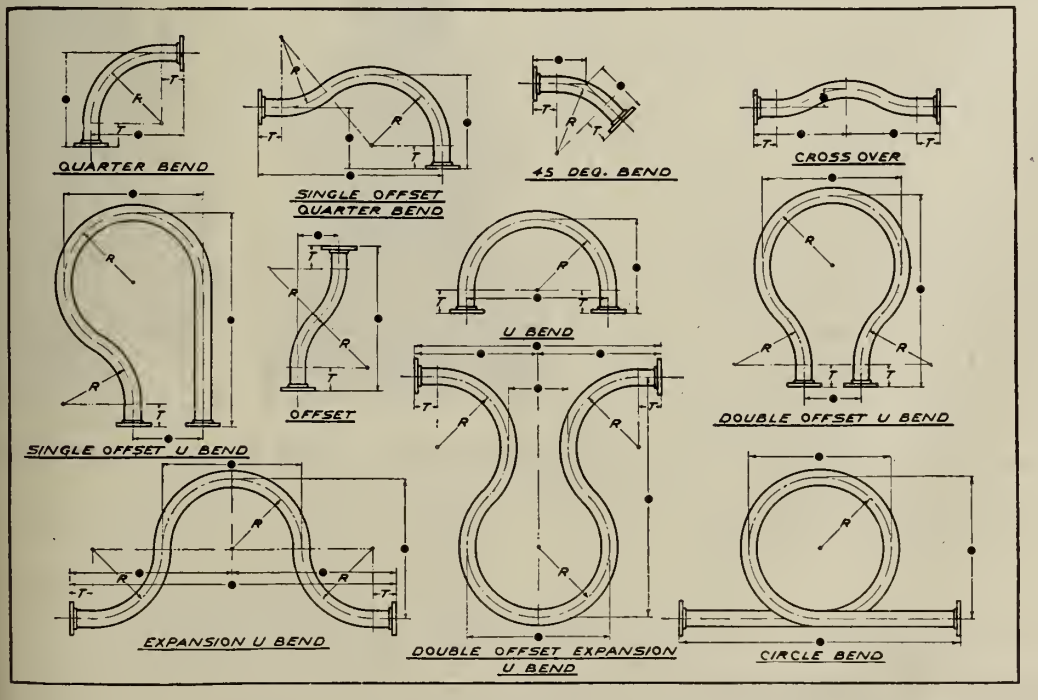
INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

PAGE WROUGHT PIPE BENDS

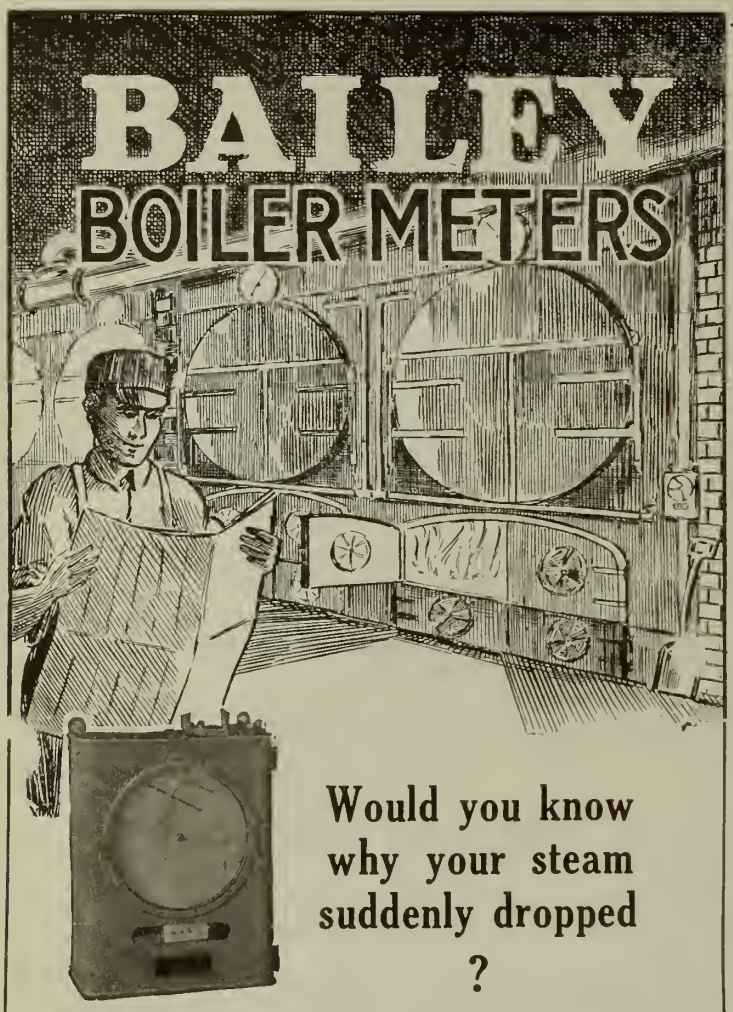


ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

100 Church Street, TORONTO, Ont.



Would you know why your steam suddenly dropped ?

A fireman leaves a fire door open while he reads the sporting events of the day. Consequently your steam pressure takes a decided drop. Would you be able to locate the cause? Bailey Boiler Meters would enable you to.

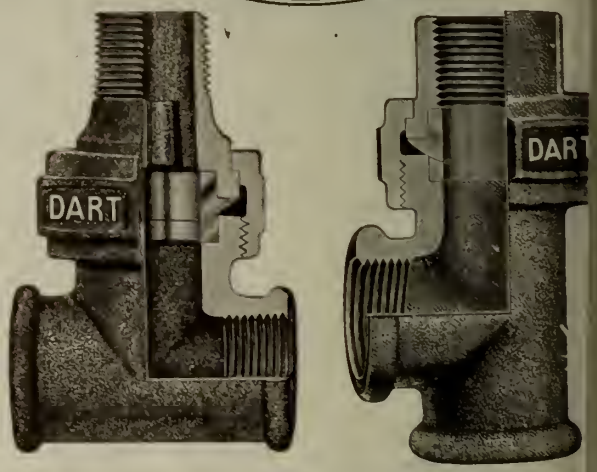
The chart records of Bailey Boiler Meters show to the engineer the performance and condition of each boiler. He can tell the presence of leaking tubes, broken-down baffles, dirty tubes, defective settings, improper feeding, or negligence of any sort on the part of the firemen. The charts are a positively dependable record of the boiler room results obtained each day.

Let us help you get the most from your coal. Write to-day for a copy of our bulletin.

Bailey Meter Company
2001 E. 46th St., Cleveland, O., U.S.A.

EVERY —Dart— Union Pipe Coupling —IS—

Bronze To Bronze At The Joint



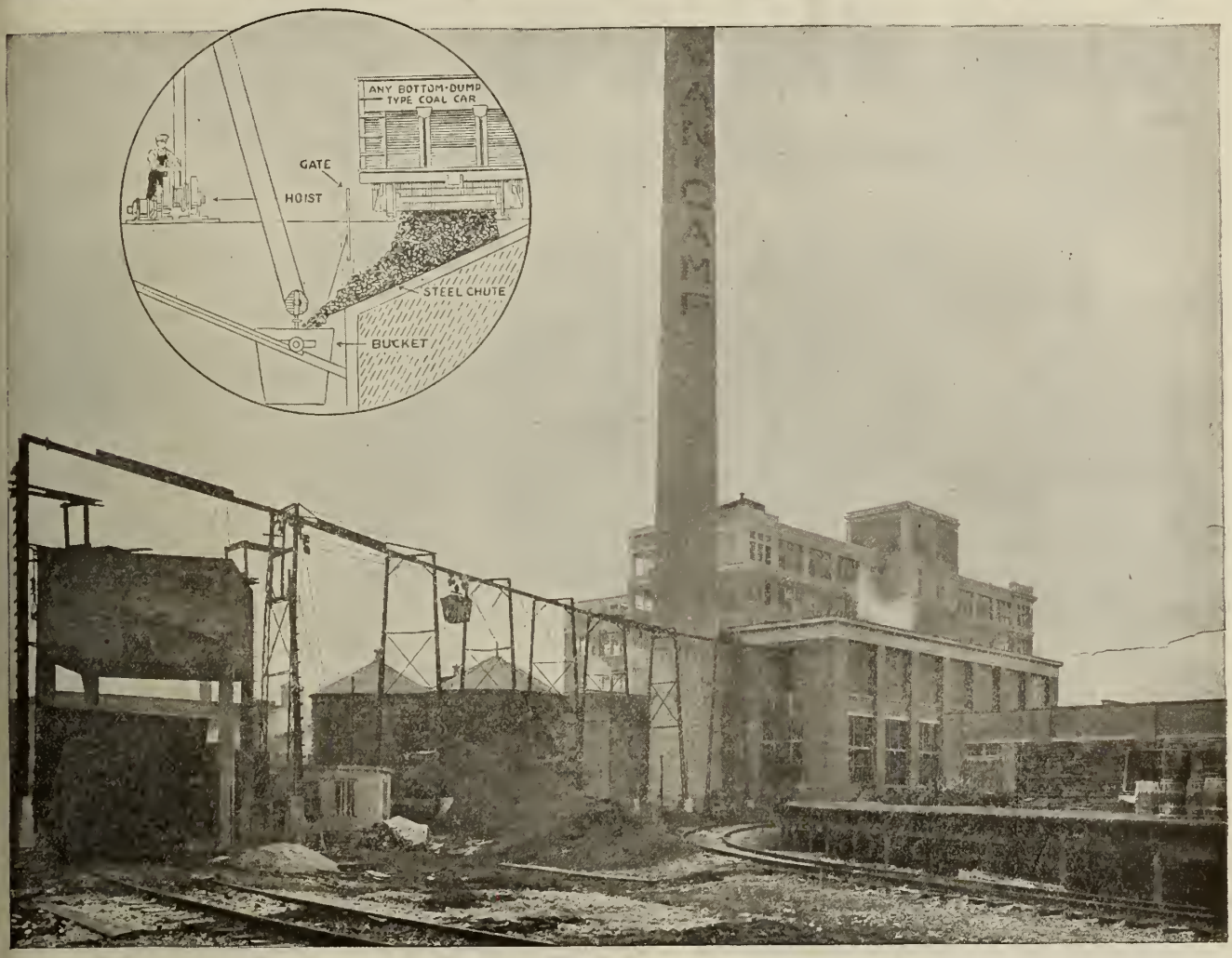
Saves Time, And Money, And Fittings

These two fittings are a combination of Union, Nipple and Tee, a saving of threads and eliminating several possible leaks.

Just examine them, and you will appreciate the value of such fittings; both styles are made with male or female Union ends. Strong, durable and fully guaranteed.

Ask Your Jobber

DART UNION CO., LIMITED
Toronto Ontario



Are Coal Handling Costs in Your Plant Reduced to a Minimum?

Large and small industries both in Canada and in all parts of the United States are using GODFREY CONVEYORS to unload, store and reclaim coal, coke, ashes and similar materials.

They are saving time and labor, releasing cars promptly, eliminating demurrage and increasing their profits. Reports received from many of the early installations show that their savings have paid for the cost of equipment during the first 12 months of operation.

YOUR COMPANY CAN DO THE SAME

A request for our representative in Canada to make recommendations and estimates involves no obligation whatever. Just tell us or them when and where

OUR CATALOGUE No. D-2 WILL INTEREST YOU.

Godfrey Conveyor Company

Factory and General Offices: 127-147 Thirteenth Street, ELKHART, Indiana, U.S.A.

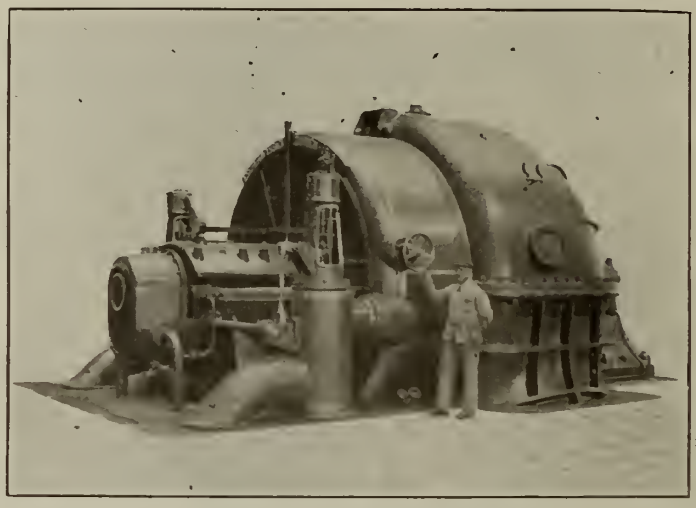
Originators, patentees and manufacturers of conveyors operating gravity-filled bottom dump bucket over monorail.

Represented in Canada by M. A. KENNEDY, Ltd., 106-110 Richmond Street West, Toronto

Escher Wyss & Co., ZURICH (Switzerland)

Montreal Office: 285 Beaver Hall Hill

Zoelly Steam Turbine



Zoelly Rotary Compressors

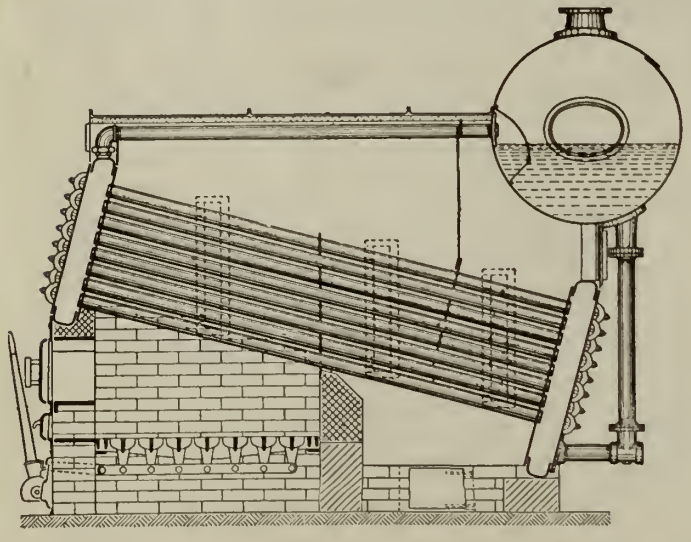
Agents for British Columbia

1,200 K.W. Zoelly Turbine

THE ENGINEERING CORPORATION, Limited, 903-906 Rogers Building, Vancouver

9-21

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N.S.

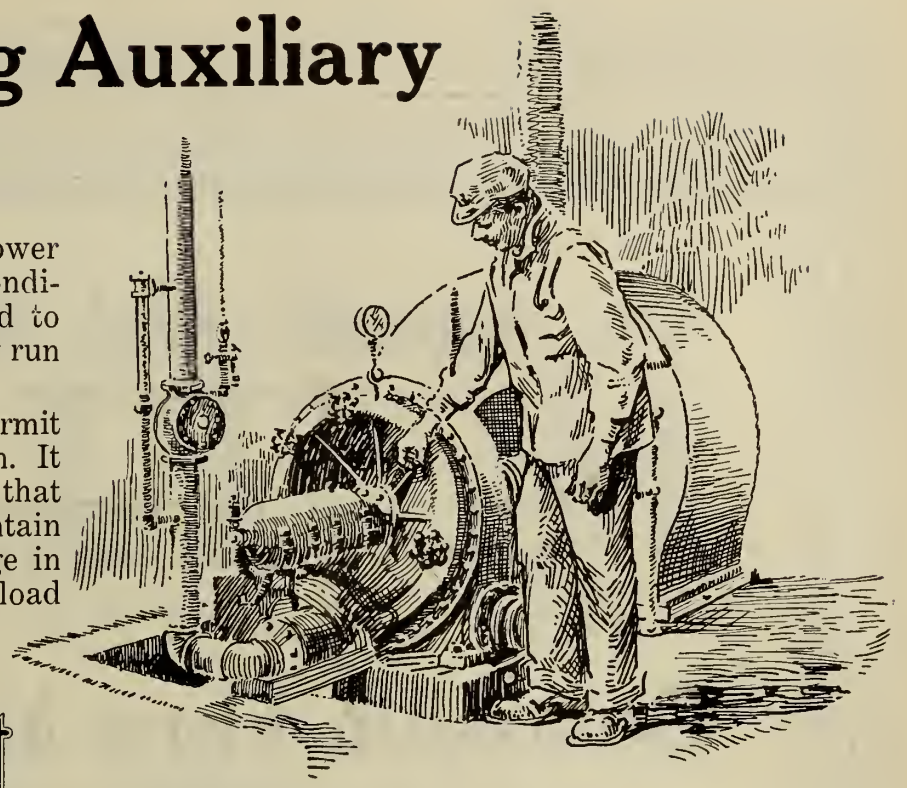
Montreal Office:
16 Cathcart Street

Toronto Office:
20 Victoria Street

Steam Saving Auxiliary Drives

The auxiliaries in the modern power plant seldom operate under ideal conditions. Most of them are subjected to severe load fluctuations and usually run underloaded.

The high price of coal does not permit extravagance in steam consumption. It is therefore extremely important that the drives selected are able to maintain a good economy over a wide range in load. Operate at nearly full load economy at one-quarter and one-half load.



Sturtevant (TRADE MARK)

Steam Turbines

They are not controlled by throttling down the steam, but by shutting off one or more of the several steam nozzles by the hand wheels on the turbine casing. The nozzles remaining in service undergo no change in efficiency.

The turbines are scientifically designed and all parts are constructed accurately to gauge of the best obtainable materials.

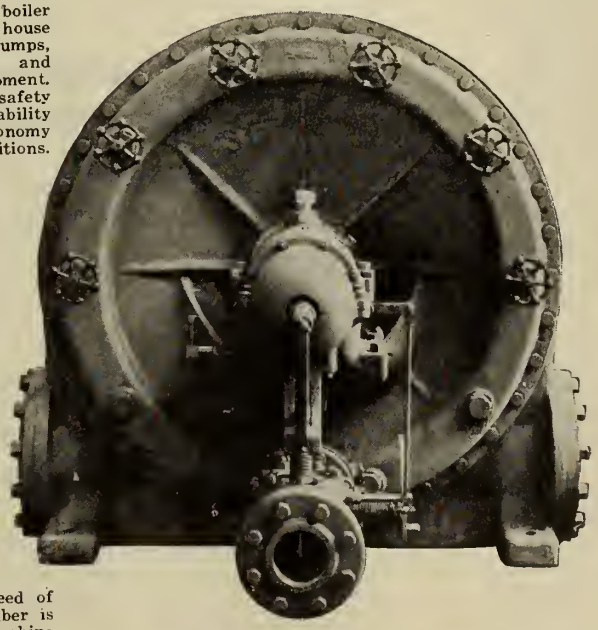
The assembly is made under expert supervision and a true running balance is established.

A positively dependable shaft governor holds the speed regulation within close limits and entirely adapts these turbines to drive electric generators.

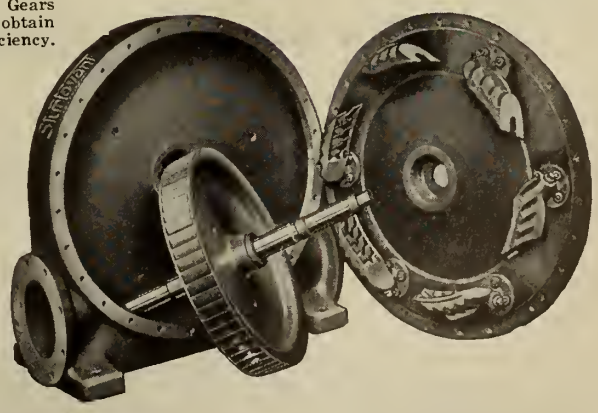
Consultation with our engineers is recommended before selecting any turbine drive.

Write for Bulletin.

Sturtevant Steam Turbines are used to drive exciters, boiler feed pumps, house pumps, fire pumps, fans, blowers and special equipment. They combine safety and dependability with high economy under all conditions.



When the speed of the driven member is below the turbine speed Sturtevant Transmission Gears are used to obtain maximum efficiency.



B. F. Sturtevant Company of Canada, Ltd.

Main Office and Works: GALT, ONTARIO

Sales Offices: Toronto and Montreal

The Republic Flow Meters Co.
of Canada, Limited

wish to notify their customers that in future the Company will be known as

Dominion Flow Meter Co.
LIMITED

The organization has been augmented (retaining the original personnel) to carry on the ever-increasing business, and we trust this change will continue to merit our customers' confidence.

The design of our equipment is in no way changed, and the service will be of the same high standard in the future as it has been in the past.

145 West Wellington Street,
Toronto

ARTHUR S. LEITCH COMPANY LIMITED

Modern Power Plant Equipment and Competent Engineering Service

The lines we handle have established an International reputation

- Edgemore Boilers
- Taylor Stokers
- Kellogg Radial Brick Chimneys
- Terry Steam Turbines
- Skinner Uniflow Engines
- Roberts Filter Mfg. Co.
- Sims Heaters
- Hays CO_2 Combustion Instruments
- Brown Indicating and Recording Instruments
- Nash Vacuum Pumps and Air Compressors
- Jennings Return Line Vacuum and Low Pressure Boiler Feed Pumps
- Dayton-Dowd Centrifugal Pumps
- Coppus Turbo Boiler Feed Pumps
- Rumsey Rotary and Triplex Pumps
- Dean of Indianapolis Steam Pumps
- Economy Sump Pumps
- Armstrong Steam Traps

Every experienced power plant superintendent and engineer knows the reliability of the lines listed above, and it will be readily appreciated that we aim to handle the most modern equipment. When you deal with us you are offered the advice of a competent engineering staff well-trained to cope with Canadian conditions and requirements.

How can we serve you ?

THE ARTHUR S. LEITCH LIMITED

1001-2 Kent Building, TORONTO, ONTARIO

Dependable Power Plant Equipment

We have the sole manufacturing rights in Canada for REES RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Jet Vacuum Pumps.

REES RoTURBo

Single and Multi-Stage

Centrifugal Pumps

REES RoTURBo Pumps give permanently efficient service on a wide range of duties. The low velocity of the water through all passages results in almost complete freedom from wear, even when gritty water is being pumped. Being self-regulating, the prime mover is insured against overloading.

The many other advantages of the Rees RoTURBo Patent Pressure Chamber pump are explained in detail in Catalog, a copy of which, along with the advice of expert Engineers, are yours for the asking.

The Goldie & McCulloch Co., Limited

Head Office and Works: GALT, Ontario, Canada

Toronto Office:
Suite 1101-2 Bank of Hamilton Bldg.

Western Branch:
248 McDermott Ave., Winnipeg, Man.

Quebec Agents:
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POWER HOUSE

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Heating The New Parliament Building

A Central Plant Has Been Installed Which Heats Nine Buildings —The Main Steam Pipe Runs Nearly a Mile From the Central Station—Forced Circulation and Indirect Heating

By T. H. FENNER

WHEN the citizens of Ottawa first heard that their post office was to be heated during the winter by a heating plant situated nearly one mile away, and that this same plant would also heat the new Parliament Buildings, and several others, there were not lacking those who said it could not be done. Dismal prophecies of failure and money wasted were freely indulged in, but to-day the plant is a complete success, and has saved money instead of wasting it.

The consulting engineer for the plant, M. F. Thomas, of Toronto, and the contractors, W. G. Edge, Ltd., of Ottawa, are both to be congratulated on the successful carrying out of the scheme, which is a big one. In fact, one cannot help but pay an involuntary tribute to the broad vision of the engineer who conceived the idea and carried out the arrangement with all the infinite details necessary to its successful completion. It is one of the biggest, or possibly the biggest, central heating scheme on the continent of America, and as it stands at present is only half the size it will eventually be, when the additions provided for are made.

Heats Nine Buildings

The power house is situated on the banks of the Ottawa River, at the foot of the cliff, round the top of which winds the famous "Lover's Walk." The cliff was cut away at this spot to admit the building of the power house, and this can be seen in the illustration of the outside of the plant. The buildings supplied with heat are nine in number, and starting from the plant and going east they are as follows: Department of Soldiers' Civil Re-Establishment, Supreme Courts, West Block of Parliament Buildings, the new Parliament Buildings, the old library which was left standing after the fire, the East Block of the Parliament Buildings, the Longtin Block on Wellington Street, and the Ottawa Post Office. Some idea of the heat supplied may be gathered from the fact that there are between 13,000,000 and 14,000,000 cubic feet in these buildings. The new building is arranged so that the air can be changed four times every hour.

The length of the tunnel from the boiler room to the post office is practically one mile, and it contains the main steam pipe, the summer heating line, the hot water circulating pipes, two in number, the steam condensation return, and the air line. These pipes are all arranged on the side of the tunnel, and a clear space left for walking and effecting repairs. The tunnel is about 8 feet high, well lighted and dry.

The Heating Plant

The entrance to the plant is from the top, which is on the street level and about 85 feet above the river bank on which it stands. The ground in front of the power plant as shown in the illustration is mostly reclaimed. The front

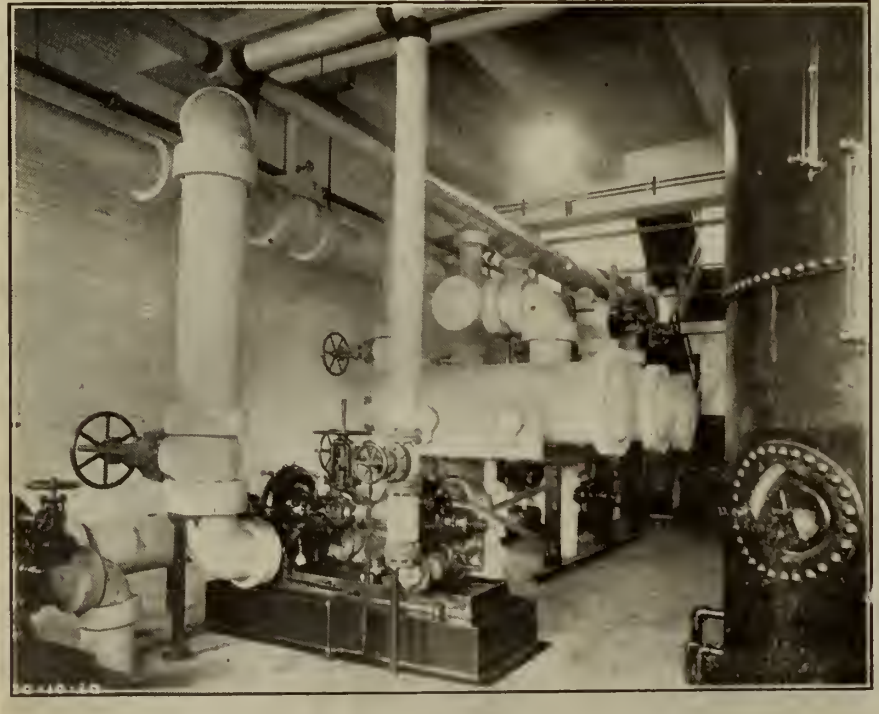
THE POWER HOUSE. THE TOP OF THE BUILDING IS AT STREET LEVEL.

wall of the building can be seen running in behind the cliff, which was blasted out to make room for it. At the other end can be seen the wall left rough to accommodate the new addition when it becomes necessary. The four square openings right in the bottom of the wall are in communication with the ash pits and supply air for the fires. They are arranged with dampers, so that the supply can be regulated in very cold weather, and according to the number of boilers in use. The top of the stack is 175 feet above the top of the boilers, and natural draught is used. On the top of the building a coal weighing scale has been provided, but this has not been in use as yet. The four windows above the square openings are in the boiler room, and the blank wall above them is the outer wall of the concrete coal bunker, which has a capacity of 1,800 tons. This is filled from the top, and at present the coal is all drawn by teams, but eventually a railway siding will be run in so that the gondola cars can unload direct in the bunker. It is quite probable that when the full plant is installed provision may be made for receiving coal by water and elevating it up to the bunker.

One enters the power house by means of a small house erected alongside the scale house, and first of all pass down three flights of iron stairs till the chief engineer's office is reached. As can be seen this is a large square space, containing the instrument board and a comfortable desk. On the other side of the partition behind the instrument board are the toilets and shower baths for the plant staff. There is ample room on this landing for the installation of a lighting plant if this should ever be considered. In fact, all through the power plant there is ample space. The means of entrance, and the continual descending of ladders after one gets in the plant, are strongly reminiscent of sea-going days, and we do not recall any plant that is quite so much up and down as this. However, it makes an excellent arrangement, and an elevator is installed to take passengers and freight from the lower floor to the street level. The boiler room can be reached by team or truck by a roadway running round the end of the power house on to the river bank, so there is no difficulty in getting supplies or spare parts to and from the plant.

ANOTHER VIEW OF HEATERS

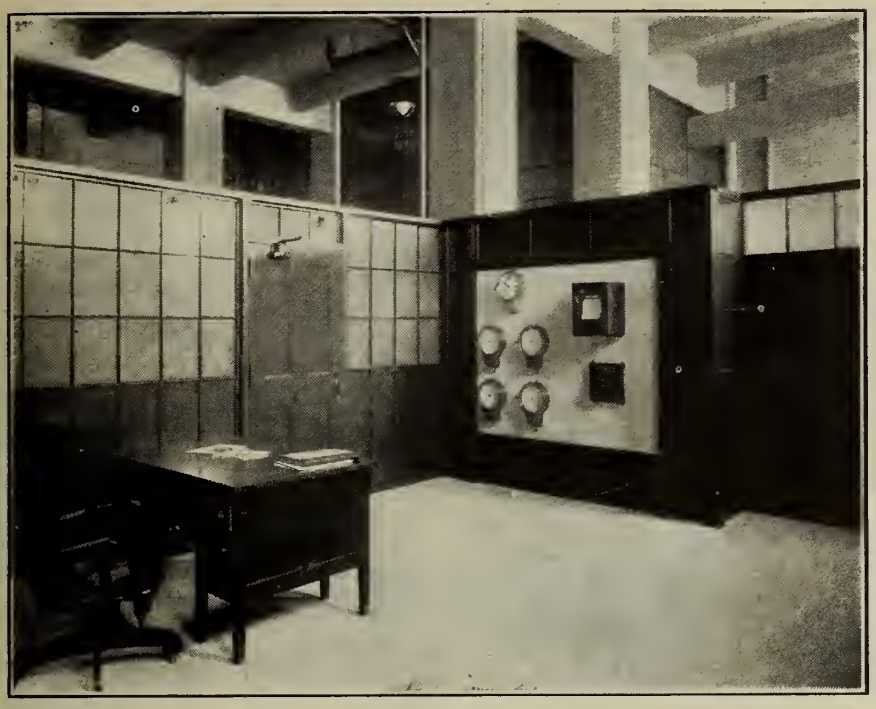
In the chief engineer's office we met the engineer in charge, W. McIninch, who took no end of trouble in showing us around and imparting all the information we could wish for. He has been on the job practically since its inception, and is thoroughly au fait with everything in connection with it. Incidentally, he takes great pride in its successful operation, and chuckles with satisfaction as he tells about those who prophesied its utter failure. With Mr. McIninch in the lead we descended some more ladders and started our trip from the proper place, that is the firing floor of the boiler room.



FORCED CIRCULATION HEATERS, PUMPS, AND EXPANSION TANK.

The Boiler Plant

The boiler plant consists of four Goldie & McCulloch water tube boilers of 500 horsepower each. They are fitted with Murphy stokers, and the grate surface is 92 square feet per boiler, a total at present of 368 square feet. The coal is fed from the overhead bunker into a travelling hopper, which automatically weighs it, a Fairbanks scale on the floor level punching a ticket, which is kept as a record of coal burnt. In the illustration the chute can be seen filling the hopper of number one boiler, and the scale suspended from the chute can be seen directly in front of the boiler. The ashes are carried along a duct under the floor by a Link Belt Co. drag conveyor, and at the far end of the building are delivered to a bucket elevator, which delivers them into an overhead bunker, from which they are dumped into the carts. Eventually, of course, there will be a siding here and the ashes will be loaded on to the railway cars direct. Each boiler is fitted with an 8-inch steam pipe, discharging into a 12-inch main header, which delivers the steam to the



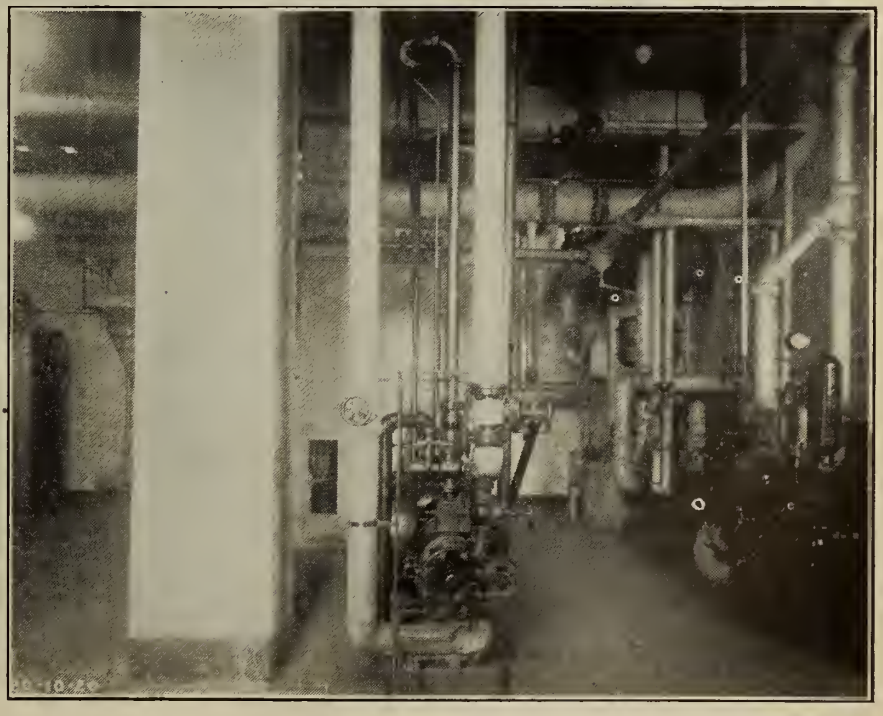
THE OFFICE AND INSTRUMENT BOARD.

buildings. This header is carried on rollers on top of the boilers, and the connections to each boiler are made through a U-bend to allow for expansion. The header itself is connected to the main pipe going through the building by a similar bend, and ample provision is thus made for expansion in both directions. Each boiler is fitted with an Ellison draught gauge, and the breeching between combustion chamber and stack of each boiler is fitted with a thermo couple, which is connected to a five-point recording pyrometer in the chief engineer's office, so that a record can be kept of the stack temperature of any boiler over any period wished. This recording pyrometer can be seen on the right of the instrument board in the illustration of the office, while just below it is the five-point switch. There is a CO_2 recorder of the Simmance Abbadie precision type fitted for all boilers. The feed header from the main feed pumps is carried along the top of the boiler, 4 inches diameter, and is reduced to 2 inches at each boiler, while the pipe leading to the second drum is reduced again to 1½ inches diameter.

The feed water is supplied to the boilers through a Webster heater and delivered to the boiler by outside packed pumps made by the Bawden Machine Co., Toronto, 16 x 9 x 20 inches. One of these pumps can be seen in the right hand corner of the illustration showing the pump room, which is on the ground floor, just alongside the boiler room. Between the feed pumps and the heater are installed the vacuum pumps, 10 x 14 x 20, which handle the returns from the steam lines and maintain a vacuum of 10 inches on the return line. These pumps were also furnished by the Bawden Machine Co. It is very creditable to the workmanship on the return pipe lines that a vacuum of 10 inches can be maintained through all the thousands of feet of pipe that go to make up the return lines throughout the buildings. On the left, close to the column, can be seen the steam-driven air compressor, while in front of that machine there is another of the same size motor driven. The compressors are Ingersoll Rand 9 x 8 and the electrically driven machine is belt-driven from a 25 horsepower 220 v. Westinghouse 2-phase induction motor. These compressors supply air at 110 pounds pressure to the buildings, and this is reduced down to the required amount for operating the thermostatic valves, elevator doors, etc., in the various departments. The main steam pipe can be seen coming down in a bend from the boiler room, and extending across the pump room ceiling. It goes up on the other side of the pump room to the floors above and the tunnel entrance. The steel ladder leading up to the upper floors can be seen just behind the square column, with the air receiving tank just to the left of the stairs.

The Forced Circulation System

The new building of the Parliament Buildings is supplied with direct hot water radiation, the water being circulated from the power house. The Commons chamber, Senate chamber and corridors are supplied with indirect heating by means of fans. The forced circulation system is installed on the third floor of the power house, that is the floor just below the street level, and a little below the entrance to the tunnel. There are three Ross heaters installed, which are furnished with exhaust steam from the pumps on the lower floor, but during the past winter one of these has been found quite sufficient to supply the new building. About 50,000 gallons of water are in circulation, and this water is circulated by a Terry turbine driving a centrifugal pump. The heaters are arranged so that they can be supplied by steam through a reducing valve in case of there not being sufficient exhaust steam to supply the necessary heat. The water in the system is under an air cushion of 90 pounds per square inch, which is supplied to the expansion tank which can be seen in the right of the illustration. A Venturi meter is installed, which is shown in the other view of the heater room, which records the



AIR COMPRESSORS, FEED HEATER, FEED PUMPS ON LOWER FLOOR.

THE BOILER ROOM.

amount of water flowing through the system at any time, as well as keeping a permanent record. The recording thermometer on the left of the board is provided with a double pen, which records the temperature of the water returning from the building. It is a remarkable fact that in the most severe weather experienced so far the difference in these temperatures has never exceeded 14 degrees. There is another recording thermometer connected to the outside air. The mains carrying the hot water to the building are 12 inches diameter. The entrance to the tunnel is in the left hand corner of the heater room and cannot be seen in either of the views here shown.

The Tunnel

From the level of the heater room one mounts a short flight of the iron ladder and then steps directly into the tunnel, which stretches away into what seems a limitless distance. The tunnel follows the course of Victoria Street, the roof of the tunnel being about four feet under the street level, and gradually mounts up towards the eminence on which stands the Parliament Buildings. It then goes under the famous Lover's Walk, and then jumps up a stage into the basement of the new building. Our illustration shows the corner where the lift is made, the iron ladder at the side being the means of getting from tunnel to basement. Before one reaches here there have been several taps off the main pipe, to supply the various buildings before enumerated, and there are some good examples of pipe bends. We have illustrated one of these, showing the main steam pipe and the two hot water pipes turning from the tunnel into the main building. On the various lines there are a large number of expansion joints, and these are all of the sleeve type, made by the Ross Heater & Manufacturing Co., New York. There are 15 of these joints on the steam line and 24 on the hot water line, with five on the return line.

The Air Washing Plant

The indirect heating plant for the Commons chamber, Senate chamber and corridors is in the basement of the new building, and is supplied with steam from the main steam line from the power plant. The fan installation consists of 17 "Vento" fans, seven of which are on the air supply and ten on the exhaust side. The total heating surface of the Vento heaters is 10,341 square feet and the capacity of the seven supply fans is as follows: 35,000, 20,000, 15,000, 25,000, 20,000, 15,000 and 15,000 cubic feet per minute, the total capacity being 145,000 cubic feet per minute. The air is supplied after passing through air washers supplied by the Canadian Blower and Forge Co., Kitchener, and there are seven of these washers. The air is first drawn over a preheating coil and then passed through a spray of water, after which it passes over another coil which dries

SOME PIPE BENDS.

PIPE RISING FROM TUNNEL TO BASEMENT ON NEW BUILDING.

Future Plans

The plant will be probably doubled in the near future, as the Government are contemplating erecting a number of new office buildings for departmental purposes, all of which will be supplied from the central heating plant. There is ample room to increase the boiler room installation by the addition of four more boilers, and it is proposed that when this is done, and the new stack built to care for them, the two stacks will be enclosed in an ornamental stone tower. This would undoubtedly give the whole structure a very pleasing appearance when viewed from the outside. In the pump room there is plenty of room for addition, and judging from the performance of the plant so far there is ample heater installation to care for everything for some time to come.

A Saving Here

While no attempt has been made as yet to obtain economical test data, pending the completion of the job in all particulars, some idea of the benefit obtained from the plant can be given. For instance, the building which was burnt down had its own heating plant, which consumed 25 tons a day. The east and west blocks burnt about that between them. The present plant has supplied these buildings and six others with ample heat on a consumption of 45 tons per day. This is a remarkable result, and amply justifies the undertaking. In all of those miles of piping we did not come across a leak, and we walked from end to end of the tunnel. A patrol is kept up of one man every shift making a complete tour of the installation and reporting on any defect he comes across. The firemen and watch engineers work in three shifts of eight hours

(Continued on page 29)

and heats it. The washers are constructed of bronze and aluminum to resist corrosion. The steam coils are all under thermostatic control. The thermostats are set to a certain predetermined temperature, and when this is reached the thermostat opens the air supply which closes the steam valves. The same arrangement is used for operating the various dampers on the air ducts and by these means a very close temperature regulation is obtained. The fans and washers are installed at each end of the building and the air is carried to the various rooms through galvanized iron ducts. The direct radiation provided in the new building is in all 44,341 square feet.

The illustration taken in the basement of the new building shows the pumps for supplying the air washers in the foreground. These are motor driven. On the left is shown the casing of one of the air washers, one of the fans being seen on the right. The air duct can be seen above, as well as some of the piping. Where this photograph is taken is probably half-way from the power plant to the extreme end of the line.

VIEW OF AIR WASHERS AND PUMPS.

A Course of Instruction for the Graded Certificate

The Subject of Valve Setting Is Taken Up—Placing the Engine on Centre — Setting the Eccentric — Setting the Slide Valve— Setting the Corliss Valve — Direct and Indirect Motion

By T. H. FENNER

IN considering the subject of valve setting we will take up first the case of a plain slide valve and assume that the eccentric is loose on the shaft. It becomes necessary then to first secure the eccentric in approximately its correct position, and also to have the valve on the spindle at as near as possible the correct distance from the end of the spindle. We are assuming, of course, that there are no drawings and no data to guide the engineer. This is often the case when an engine that has been out of use for some time may be again put into service, or perhaps a second-hand engine has been bought and shipped knocked down, or it may be a new engine which the operating engineer has to erect himself.

In most stationary engines the eccentric is secured to the shaft by set-screws only. If it is keyed on, of course, there will be no trouble in finding its correct position, but the set-screw is the usual method of fastening. In order to get the valve at approximately its correct position turn the eccentric round on the shaft until it is at its extreme position on the inward side of the shaft, and measure the amount the steam port is open. Then turn the eccentric round to its extreme position on the outside of the shaft, and measure the port opening at the other end. These should be about equal, and if they are not, move the valve on the spindle until they are. The valve is now close enough to its position to allow the eccentric to be set. In order to do this the engine should be set on the centre at either end.

The method of setting an engine on the dead centre has been described so often that we feel like offering an apology for doing it again. There are, however, always a certain number of men who have not had the job to do and who have not read about it, so it will be described briefly here.

Placing the Engine on Centre

Turn the engine over until the piston is nearly at the end of its stroke at whichever centre you are going to mark first. When the crosshead is about two to three inches from the end make a mark on the guide shoe and a corresponding one on the crosshead. Then take a piece of round iron or steel pointed at one end and turned into a right angle at the other end, which is also pointed. Make a centre dab on the frame of the engine and place the straight end of the trammell or round iron in this centre dab, while with the other end a mark is described on the crank web or flywheel, whichever is most convenient. Now turn the engine over the centre until the mark on the crosshead and guide correspond again, and scrive another mark with trammell on the crank or flywheel. If the space between these two marks is divided, and a mark made between them, and centre dabbed, the turned point of the trammell will just fit into this mark when the engine is on the dead centre. One might think that a mark placed on crosshead guide at the end of the stroke would be sufficiently near, but this is not so, as there is always a certain amount of wear taking place, which would cause false indications to be given by a mark of this kind. Once the mark is made by the trammell it is correct for all time, as long as the trammell itself is not bent or abused. The accompanying illustration shows the method clearly.

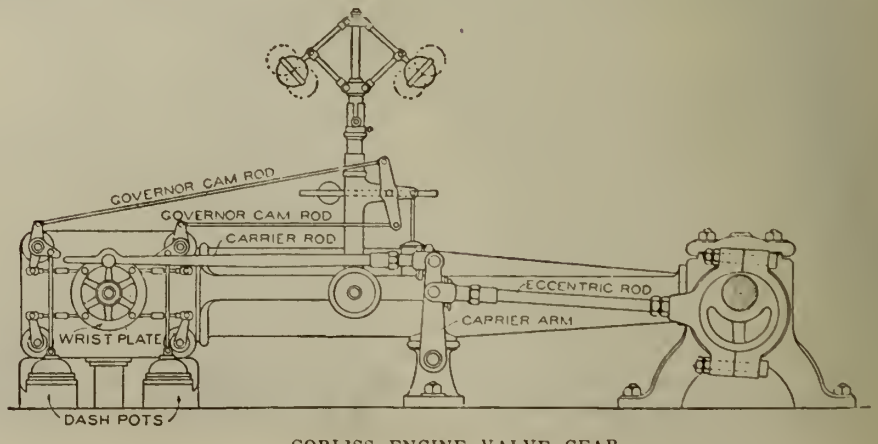
Setting the Eccentric

Having placed our engine on the centre, the next step is to turn the eccentric round on the shaft until the valve is just open to steam at the same end that the piston is at. That is, the valve is admitting steam to the piston to move it on its stroke. Secure the eccentric temporarily at this position and turn the engine round on to the other centre, finding the centre in the same way as the first one was found. The valve should be open practically the same amount on this end as it was at the other. Let us go into a little more detail.

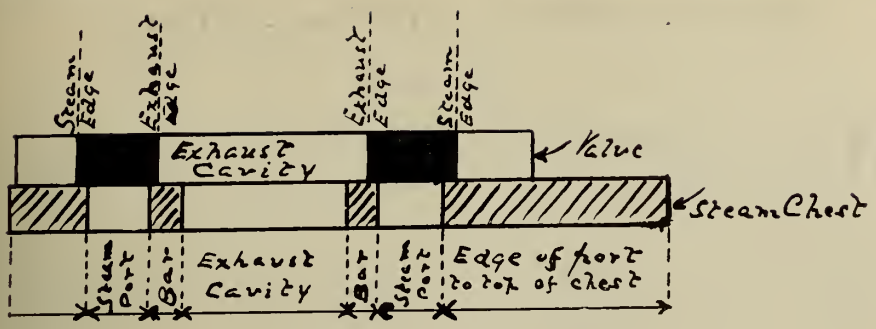
Suppose we set the engine on the head centre first, and set the eccentric so that the valve is open to steam 1-16th inch when the crank is on the dead centre. We now turn the engine around to the crank centre and find the valve is open to steam 3-16th of an inch. Now if the valve is moved down on the spindle 1-16th the lead will be equal each end. We want to have a little more lead at the crank end on account of the effect of the connecting rod, which we have explained before, but if we have 3-16th at one end and only 1-16th at the other it is rather a lot. We want to get a little more lead on the head end than 1-16th, and still have a chance to give the crank end a little more lead than the head end. The only thing to do is to advance the eccentric on the shaft. Turning back to the head end centre, move the eccentric till we have the valve open to steam 1-8th inch, and then move the engine over to the crank end again. We shall now find that we have increased the lead on the crank end to 5-16ths. That is a difference of 3-16ths between the head and crank end. Now if we move the valve on the spindle towards the crank end one-sixteenth, we shall have 3-16ths at the head end and ¼ inch at the crank end, which should be about right. These amounts would vary, of course, with the size of the engine, but the idea is just the same.

Now while the cover is off it is a very easy matter to check up the cut off points at each end of the cylinder by slowly turning the engine round and noting the position of the crosshead when the edge of the valve just covers the steam port on head and crank end. The exact moment when released can also be determined by the use of staffs which will be explained and thus every position of the valve may be known at the time it is set. Generally speaking, if the leads are right at each end the other positions will take care of themselves.

We have seen that in setting the valve described above we have adjusted both the position of the valve on



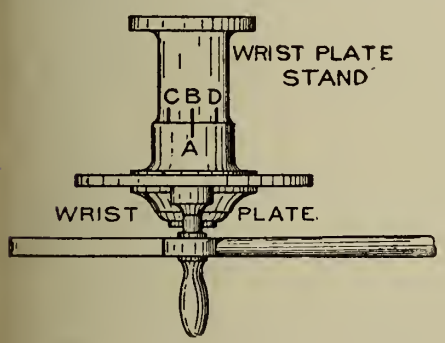
CORLISS ENGINE VALVE GEAR.



STAFFS FOR SETTING VALVES.

the spindle and the position of the eccentric on the shaft, and from what we have said in previous lessons the student should be able to deduce some useful rules.

The first thing that will occur to the thoughtful reader is that by altering the position of the eccentric every function of the valve is altered. We have shown this before in speaking of valve diagrams, but it has been our experience that this fact seems hard to grasp by many young engineers. It is simply this: When the eccentric is placed further ahead of the crank and the crank is at dead centre, then, of course, the eccentric is that much more ahead of the crank all the way round. Then the rod and valve which are operated by the eccentric will be at the end of their



MARKS ON WRIST PLATE AND PIN.

stroke and have started to return when the crank has moved through but a small angle and thus will cut off the steam from the piston at a much earlier portion of the stroke. At the same time the exhaust edge of the port will be opened sooner, thus making release earlier, and the extreme end of the stroke being reached the valve starts its return journey, making compression earlier, and also opening to steam long before the piston reaches the end of its stroke. If the eccentric is set too far back the opposite results occur and every operation is late. Therefore, when setting a valve, if you find that lead is late at each end and cut-off is late at each end, then the eccentric must be moved ahead on the shaft. If the lead at each end is too great and cut-off is taking place too soon, then the eccentric must be moved back.

This same method of setting applies to the double ported valve, and the piston valve. With a piston valve it is, of course, very hard and in some cases impossible to see the amount of lead when the steam is taken on the inside, and in this case the method of using staffs is resorted to. This consists of making a staff on which is marked off the position of the ports in the valve chest or the liners, and a second staff which is made to conform to the bars on the valve. The valve is set by measuring the distance of the valve from the end of the casing and then laying the staff which represents the valve on the staff which represents the casing at exactly the same distance. The position of the ports can then be plainly seen and the adjustments made accordingly.

We have seen above the method of placing the eccentric in position and getting the valve in its position on the spindle when the eccentric is loose on the shaft. After making these adjustments it is necessary to take an indicator diagram to make the final adjustments, and these we shall deal with in due course. Before coming to that we will take up the setting of Corliss valves and other types of drop gear valves.

Setting the Corliss Valve

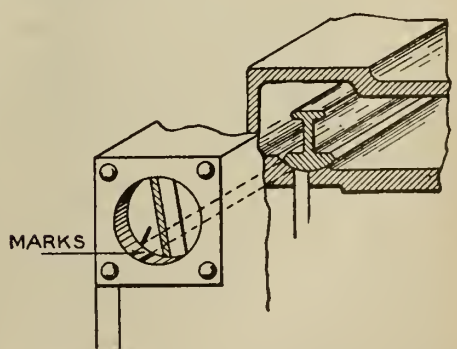
Corliss valves are operated either by one eccentric and a wrist plate, to which the reach rods of all four valves are connected, or by two eccentrics, one of which operates the steam valves and the other operates the exhaust valves.

The first thing to adjust on a Corliss gear is the reach rod, which operates the wrist plate. This rod is usually operated from a lever placed on the engine frame, which is operated by the eccentric rod direct. The eccentric rod length is fixed, but the reach rod is made adjustable, usually by a right and left-hand thread in its length, which makes it possible to either lengthen or shorten it. The wrist plate is usually marked by the makers with a chisel mark, and this mark corresponds with marks on the wrist pin. There are usually three of these, one in the centre and one each side of the centre. These two outside marks show the limit of travel of the wrist plate. The eccentric being left loose on the shaft is turned through one revolution, and the marks on the wrist plate and pin carefully watched. The mark on the wrist plate should travel from one outside mark on the pin to the other, but no further. If the wrist plate travels too far towards the head end the reach rod must be shortened, while if it goes too far to the crank end it should be lengthened. This is fairly obvious. This is the first part of the adjusting and must be correct before anything further is attempted.

The next step is to move the covers from the back side of the valve chambers, that is the side away from the gear. When the cover is removed there will be seen marks on the end of the chamber corresponding with the port opening and marks on the valve end which correspond with the face of the valve. The end of the valve is circular, but the part that does the work is of T shape, the stroke of the T being a part of a circle of the same radius as the bore of the valve chamber. Now turn the eccentric round on the shaft till the centre mark of the wrist pin is in line with the mark on the wrist plate. The valves will then be in approximately mid position. In this position the steam valves should be overlapping the steam ports by about one-quarter to seven-sixteenths of an inch, according to the size of the engine. The exhaust valves will be also in their mid position, that is, just about to open. The exhaust valve on one end will, of course, be closed when the steam valve is open.

The steam rods, or reach rods, connecting wrist plate and steam arm, and the exhaust valve reach rods connecting the exhaust valves to the wrist plate, must now be adjusted by their right and left hand screws until the valves are in correct position, as nearly as possible. After this is done, turn the engine over to the dead centre at either end.

The governor must now be raised on to its stop, so that the steam hooks will engage. Now turn the eccentric round on the shaft until the valve at the end where the piston is just opens to steam by the amount of lead required, say 8 inch. Then secure the eccentric on the shaft, as this will be its angle of advance, approximately. Now turn the engine over to the other centre, and the valve at that end should also show the amount of lead required. If not, adjust the rod to give the required lead.



MARKS ON END OF CORLISS VALVE.

The governor reach rods should now be lengthened or shortened until the cam knocks off the steam hook at about half-

stroke, when the governor is resting on the stop. The stop should then be taken out from under the governor, so that it will drop, and the safety cam should then come round so as to prevent the steam latch from engaging at any point in the stroke. The valves are now set as nearly as can be done without the indicator. They are close enough to allow the engine to turn over under its own steam, and a diagram can then be taken, which will allow further adjustment.

With Two Eccentrics

When the engine has two eccentrics the exhaust and steam valves are driven independently, which makes the adjusting a still easier matter. The steam valves are set in the same manner as with the single eccentric, and the exhaust valves are adjusted separately by the marks on their own wrist plate. With two eccentrics the adjustments, being absolutely independent, can be made much finer than with the single one, because they are not limited by the effect of one upon the other.

Indirect Motion

The eccentric rod of a Corliss engine practically always drives a rocking lever, and it will depend upon whether the reach rod that drives the wrist plate is upon the same side of the fulcrum as the eccentric rod, or on the opposite, if the motion is direct or indirect. If the reach rod is pivoted upon the opposite side of the fulcrum of the rocking lever to that upon which the eccentric rod is pivoted, the two rods will have opposite motions. In this case the eccentric must be set behind the crank instead of ahead of it. This also applies to a piston valve which takes steam upon the inside of the valve instead of the outside. In this case the angle of advance will be towards the crank instead of away from it, or in other words, the eccentric will be just 180 degrees from the position it would occupy if driving direct.

We may sum up the setting of a Corliss engine in the following way. First adjust the reach rod so that the wrist plate has equal travel on the wrist pin. Then with wrist plate in its central position adjust the steam rods so that the steam and exhaust valves are in mid position. Turn the engine on the dead centre and move the eccentric around until the valve has the required amount of lead. Adjust the eccentric on the shaft. Adjust the governor reach rods so that the cam will release the valve at half stroke, when the governor is down on its stop. Take the stop out from under the governor and make sure that the safety cam throws the steam hook clear of the die when the governor is in this position. Make all fast and turn the engine over by steam, adjust the valves in the dash pot so that they pull the valve down sharply and take an indicator card.

Some Notes on Anhydrous Ammonia

By W. C. KLOTZ

MANY of those operating refrigeration plants, when asked what anhydrous ammonia is, may reply, "Why, it's the stuff we put into the freezing plant to make ice," and beyond a few fundamentals this possibly comprises their whole knowledge of this important industrial chemical, which they daily make use of in their routine work. Since it is well to have at least a fair knowledge about the materials one is working with a short discussion of the everyday characteristics and actions of anhydrous ammonia as it affects working conditions may be in order.

Two Greek words meaning 'without water" form the derivation of the term anhydrous, and so the meaning of the whole world is free from water. Strictly speaking, therefore, the name can be applied to ammonia either in gas or liquified form, but commercially it is used only in referring to the latter, viz., ammonia gas liquified under pressure.

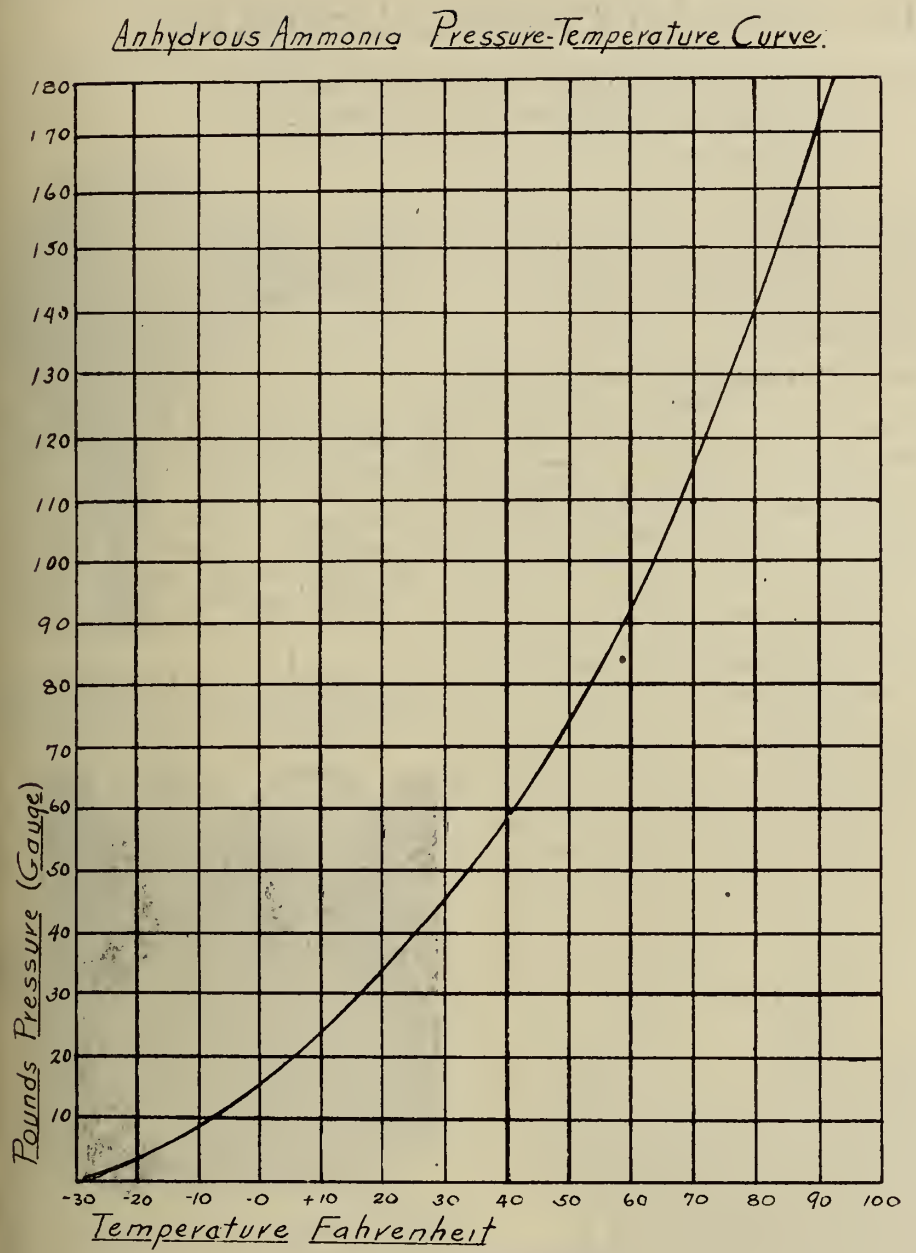
Under ordinary atmospheric pressure anhydrous ammonia boils at —28.5°F., and at —103.9°F. it freezes to a solid mass without any odor. Expansion into a gas increases its volume to the extent that one pound of the liquid at 70 deg. F. when allowed to evaporate would fill a room space of 22.6 cubic feet.

In appearance and action anhydrous ammonia is strikingly like water in many ways. It can be frozen to a white solid resembling ice, this can be melted by heat to a colorless liquid like water, and by application of more heat can again be vaporized to a white vapor similar to steam. It will dissolve sugar, sal ammoniac and such materials, and the solution can be evaporated, leaving the materials intact as before. Starch dropped into liquified ammonia will swell up very much like it does with water. But anhydrous ammonia can dissolve substances that water cannot. For instance, sulphur will dissolve slowly, forming a greenish liquid in the open, and purple under pressure, and rubber and gums are also acted on to a certain extent. Metals such as iron, aluminum, lead, nickel, etc., are unaffected by it while copper and zinc are more or less slowly attacked. Anhydrous ammonia is but an indifferent conductor of electricity, but presence of water in it increases the conductivity.

Although at —28.5°F. anhydrous ammonia exerts only atmospheric pressure, yet increase in temperature causes a rapid pressure rise, far more so than the proportional temperature increase. This can best be seen from the accompanying pressure temperature diagram illustration, in which the horizontal lines represent degrees Fahrenheit, and the vertical lines the gauge pressure. By following up the line for any given temperature until it meets the curve, and then drawing a horizontal line to the pressure scale, the corresponding pressure value can be at once noted. In order to raise the pressure by 20 lbs. from 0 to 20 (gauge reading) an increase of 34.5 deg. F. is necessary. To raise it by the same amount from 80 to 100 requires 10.5 deg. F., while to raise it similarly from 180 to 200 requires an increase of only 6 deg. F. As the pressure of ammonia in compression under average working conditions approximates the latter figures, the reason for care in the regulation of condensing apparatus becomes apparent.

If a current of air is passed through a flask of anhydrous ammonia the temperature will gradually drop away down to —112°F. from excessive evaporation. As this temperature is below the freezing point of ammonia, crystals of solid ammonia "ice" will soon commence to form and will again disappear as the liquid is allowed to warm up, melting in the liquid like ordinary ice.

As stated, anhydrous ammonia, boiling freely in the open air, will show a temperature of —28.5 deg. F., and this, under correct atmospheric pressure conditions, forms a good test of ammonia purity, but this does not mean that a thermometer placed in a flask of ammonia and left there will necessarily read —28.5°F. As a matter of fact, unless the contents are kept boiling the mercury will gradually go down to —34°F., or lower, according to the temperature of evaporation. Now if the flask is again made to boil by placing in cold brine, the temperature will once more rise to —28.5°F., and remain there as long as outside warmth is applied. Again, if we take a sample of anhydrous ammonia in a glass flask, and another in an iron cup, set them side by side, and insert a thermometer in each, the temperature of the glass sample will almost immediately commence to drop to about —34°F., while the iron one will remain for some time around —30°F. The reason is that the iron, being a conductor, will release heat readily to the evaporative requirement of the ammonia, keeping the temperature up, while glass, being a non-conductor, yields no heat to the contents, which consequently must get the necessary evaporative heat from wihin, and hence quickly falls in temperature. The same thing is true of anhydrous ammonia spilled on a piece of wood and a piece of iron. Although both samples are identical the spot on the wood will remain inert or dead, look like a water stain and feel damp to the hand for some time. while that on the iron will bubble and evaporate freely and quickly disappear. In more than one refrigeration plant where anhydrous ammonia has been allowed to drop on a wood floor and the apparent lifelessness of the liquid noticed, the conclusion has been arrived at that the ammonia was



TEMPERATURE PRESSURE CHART.

wet or otherwise faulty when such was not the case. In fact the presence of moisture in a sample of ammonia will actually increase the bubbling.

The presence of water, or soluble impurities, raises the boiling point of anhydrous ammonia according to the amount present. The following table gives the corresponding temperatures at which anhydrous ammonia, containing fixed quantities of water, will boil in the open under standard atmospheric pressure:

% Anhydrous	% Water	Boiling Temperature
100	0	—28.5°F
95	5	—22.0
90	10	—17.5

But while the 100 per cent. sample will retain a constant boiling temperature the others will not. When a mixture of anhydrous ammonia and water commences to boil the anhydrous will evaporate off, but not the water, hence the longer it boils the larger will be the proportion of water, and consequently the temperature will keep creeping up in proportion.

Also unless care be taken the thermometer readings may be decidedly misleading. As an example, two samples were set side by side in the writer's laboratory, in glass flasks, open to the air. One was in its original pure condition and to the other 5 per cent. of water had been added. A thermometer was placed in each flask. The pure sample was kept boiling by being placed in cold brine, and the diluted sample was left quiet. The readings of both thermometers were within one degree of each other, viz., —28, —29°F. In other words, both samples passed an approximate temperature test of pure ammonia, yet one was known to contain a large amount of foreign matter—5 per cent. water. Had the diluted sample been kept boiling, the temperature would have risen to —22°F., an ample assurance of the presence of foreign substance. The practical application of this is that an engineer, drawing a sample from his machine and relying on a temperature test without observing the proper conditions may easily come to the wrong conclusion that, since the temperature noted was that of a pure ammonia sample, the ammonia should be satisfactory, but as it will not do its work satisfactorily in the system the original lot must certainly have been bad.

These various conditions all depend on the ability of the ammonia to get heat to permit it to evaporate without drawing on its own contained heat, and while temperature and evaporative tests form a correct indication of its condition, care must be taken that wrong conclusions are nit deduced from the results obtained.

The injurious effects produced from ammonia laden air form a subject of much discussion and difference of opinion. While an excess of the gas is harmful, just as any other chemical gas would be, still small quantities in the air are harmless beyond producing temporary headaches and irritation in the eyes. Fortunately the very pungent nature of ammonia gas prevents prolonged breathing in any quantity and so acts as a rule as its own safeguard. Its strong odor at once gives warning of its presence even in minute quantities, for as little as 0.05 volumes of ammonia per 1,000 of air can be detected in a room; 0.3 volumes per 1,000 of air can be endured for some time without bad results, but 2 volumes per 1,000, when inhaled for any length of time are dangerous, since they produce irritation of the lungs and other breathing organs with danger of consequent inflammation. They do not, however, when merely inhaled, affect any other part of the body in consequence.

HEATING PARLIAMENT BUILDINGS

(Continued from page 25)

each, and there is an engineer in charge on duty all day and one all night. There is ample opportunity in the summer when Parliament is not in session to carry out all the repairs that may be necessary.

Steam is also supplied to the parliamentary kitchens for cooking purposes, and there is, of course, an enormous demand for hot water for domestic purposes in such a huge building. The central plant takes care of it all and to everybody's satisfaction.

It is cause of satisfaction to think that this big job was designed by a Canadian consulting engineer and carried out by Canadian contractors. As much of the material as possible was obtained in Canada. It should make those among us who think they must always go to the United States for a consulting engineer pause and consider the engineering talent available at home. Those engineers who are going to attend the C.A.S.E. convention in Ottawa this year should certainly not miss the opportunity to visit this interesting plant.

Some Results with Mechanical Stokers

This Article is the Second One on This Subject, and in it The Various Methods of Installation are Described and Illustrated

By ROBERT JUNE

SOOT as found in steam boilers varies considerably in appearance and composition, depending upon the grade of coal burned, conditions of combustion and part of the furnace from which the sample is taken. Nearest the fire the deposits formed consist largely of ash. Analysis of samples of soot, taken from a boiler, shows in addition to the "pure soot" the presence of silica, alumnia, iron oxide, various alkalies and sulphur dioxide.

In all but the coolest portion of the setting, soot is usually gritty in texture. The grains may be as large as medium size sand or as fine as cigar ash. These particles are in a plastic state when they leave the furnace, and striking the boiler they adhere to the

FIG. 1 — Typical installation of Soot Blower System on a horizontal return tubular boiler. Door is shown transparent in order to show piping and method of operating main blower valve from floor.

tubes. If this deposit is not removed frequently it quickly increases in amount and changes in character. The carbon burns out in part and the mass cements together. The repeated reduction in heat-absorbing surface increases the temperature of the flue gases so that the process of cementation is continuous and constantly increasing in intensity. An extremely hard, clinker-like formation results. In a short time the tubes in some portions of the boiler are thickly coated, thus materially reducing its capacity.

In our discussion last month we dealt with figures of actual tests conducted to determine the efficiency of mechanical soot blowers with various types of fuel, such as anthracite and bituminous coal, pulverized fuel and oil. We found that mechanical soot blowers would effect a saving of 4 to 8 per cent. in fuel and also effect an important reduction in labor, so that the importance and value of mechanical soot blowers was self-evident.

The Five Essentials in Preventing Soot Waste

The five essentials in preventing soot waste are:

1. Frequency of cleaning in order to minimize the cumulative effects of increasing deposits. Tubes should be cleaned three or four times in twenty-four hours.

2. Thoroughness of cleaning, in order to maintain high furnace and boiler efficiency and prevent the corrosive effects of soot accumulation.

3. Availability of system. The soot cleaner system should be instantly available, automatic in action, capable of rapid operation.

4. Durability of system. The blower units should be so designed and constructed that they will withstand the stress of hard service without the necessity for frequent repair or replacement.

5. Economy in operation. The soot removing system should be cheaper in operation than hand blowing; it should be so installed as to prevent the entrance of cold air into the furnace during its operation: it should not interfere with the operation of the boiler; it should pay for itself from an investment standpoint.

Soot Blowers for Horizontal Return Tubular Boilers

Soot blowers were first manufactured on a commercial basis for Scotch marine boilers on the Great Lakes. The blowers were what is known as the "rear end" type, being installed through an opening in the water leg in the rear. It was only natural, therefore, when soot blower manufacturers began to develop equipment for stationary horizontal return tubular boilers that they should start in by adopting the rear end blower on Scotch marine boilers for this purpose.

For a good many years it was the universal practice of all soot blower manufacturers to make only rear end equipment for horizontal return tubular boilers. The rear end blower had numerous disadvantages, however, and about eight to nine years ago soot blower manufacturers generally began to produce front end blowers. While rear end blowers can still be purchased from one or two of the older manufacturers, they are seldom recommended and practically every manufacturer of this type of equipment manufactures and recommends the front end blower to the exclusion of the older type.

A typical installation is shown in Fig. 1. This consists of a blower arm inset with Venturi nozzles and placed at the front end of the boiler. The position and arrangement of the blower are such that when it revolves the nozzles direct the steam jets directly into every tube of the boiler. With an initial pressure of 150 pounds this steam is shot from the nozzles at a velocity of approximately 2,700 feet per second. As can be imagined, the effect is to remove every bit of the soot and fine ash deposit.

The blower unit is attached to the door, and when the door is opened the entire mechanism swings with it, leaving the boiler ends free and clear for inspection repairs, etc., and exposing and making easy of access any part of the blower.

FIG. 2 — Detailed view of the revolving unit installed in a horizontal water tube boiler. The method of supporting blower units on tubes, and the position of the units and nozzles relative to the tubes, is practically the same on all types of horizontal and vertical water tube boilers to which this system can be applied. Notice there is a Venturi nozzle for EVERY space between the rows of tubes.

Both the tubes and the combustion chamber are cleaned at the same time. The sweeping of the arm as it swings in a complete circle allows the steam to be shot directly into the tubes on a straight line, and the corner tubes are taken care of with the same thoroughness as the centre ones.

The blower being at the front end of the boiler, and the entire mechanism controlled from the outside, it is easy to get at and operate, making the cleaning of the boilers three or four times a day a simple process. Each operation will consume only about a minute's time.

One of the most important advantages attaching to the use of mechanical soot blowers is the absolute exclusion of cold air from the boiler. The boiler doors are always shut tight when the blowers are in operation, and it makes no difference what load the boiler is under. In

FIG. 3—Head of Model "G' Unit used on water tube boilers. Note the strong symmetrical construction. The use of the gooseneck permits the steam main to be brought close to the boiler setting, thus adding greatly to the appearance of the installation.

fact, the more the boilers are being forced the more need to clean the tubes. This cleaning cannot be done with a hand hose without reducing the load. It can be done in a few moments right at the peak of a load with mechanical soot blowers and all of this is accomplished without any reduction in efficiency caused by admission of air.

Equipment for Water Tube Boilers

For cleaning water tube boilers of the usual horizontal type, vertically baffled, and for cleaning most types of vertical boilers and economizers, the equipment supplied by the principal manufacturers commonly consists of a permanent installation of revolving units located at various points in the passes of the boilers. In a typical installation, Figs. 2 and 3, the equipment consists of five principal elements, as follows:

1. A head through which the steam passes from the main soot blower supply line when the valve is opened. The head is the foundation element to which the other elements are attached.
2. A wall box which is bricked into the setting. The box supports the unit, and is so constructed that the blower can be turned freely without admitting air to the inside of the setting.
3. A blower element running crosswise of the bank of tubes and consisting of a small header with nozzles so placed as to discharge steam between the boiler tubes.
4. A sheave or hand wheel by means of which the blower element is rotated.
5. Bearings attached to the boiler tubes which support the blower element and permit it to revolve freely.

Soot Blowers for Horizontal Water Tube Boilers

The general arrangefent of the units in horizontal water tube boilers consisting of a single bank of tubes is shown in Fig. 4. It will be noted that a unit is shown over the arch at the bottom of the first pass. This is extremely important inasmuch as this is the point where the gases first strike the boiler and where the largest deposits of soot and ash are to be found. This is also the hardest working part of the boiler, as the temperatures are highest here and the transfer of heat to the water is most rapid.

In order to maintain this rapid transfer of heat, the deposits of soot and ash must be removed at frequent intervals. As the temperatures are extremely high at this point, the problem has been presented to soot blower manufacturers in designing a unit which would stand up and perform its functions satisfactorily. The problem has been solved by treating the unit by a special process known as "Calorizing" to prevent the burning of the metal at high temperatures and by placing the unit close against the front header of the boiler behind a baffle so that the blower unit will stand up in this location for six months to three years and in some cases even longer. As the cleaning of this part of the boiler is of vital importance, power plant operators have found that they can well afford to replace the blower pipe of this unit from time to time as conditions warrant.

The second unit is located at the top of the first pass in a position which enables it to clean the superheater as well as the boiler tubes. The frequent cleaning of the superheater is essential to the maintenance of high and uniform steam temperatures and an individual soot blower unit for this purpose is frequently provided. The remaining units in the boiler are located as strategic points in the passes.

Soot Blowers for Vertical Water Tube Boilers

The world's largest boilers are of the vertical type, and it is a notable fact that these large boilers almost without exception are equipped with mechanical soot blowers. Proper arrangement of the units is one of the most important factors in the success of these installations. In the Stirling, Connelly, Kidwell and similar boilers the thorough cleaning of the tubes at the bottom of the first pass is secured by the installation of calorized units. Temperatures are high at this point and the calorized metal withstands high temperatures without oxidizing.

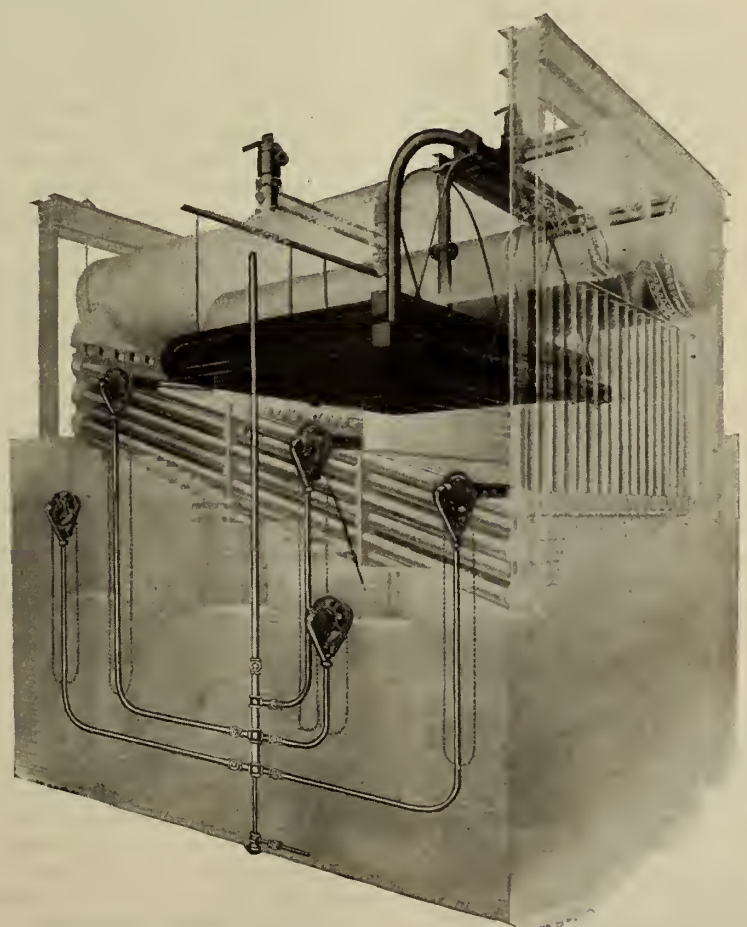


FIG. 4—APPLICATION OF THE MECHANICAL SOOT BLOWER SYSTEM TO HORIZONTAL WATER TUBE BOILER, VERTICAL BAFFLE TYPE WITH SUPERHEATER.

One of the principal requirements of a successful soot blower installation for vertical boilers is that the system employed shall allow the steam jets to play effectively over the whole gases by unnecessary obstruction. The number and location of the units in vertical boilers varies with the different sizes and types of generators. The number of units will run from five in the small Stirling boilers without superheater to thirty-two in the big W type of 2,365 h.p. such as are used at the plant of the Detroit Edison Co. and other large central stations.

With Wicks boilers, Fig. 5, the problem of design is complicated by the fact that economy in space is one feature of Wicks installation and that the boilers are therefore often set in solid batteries, rendering it difficult to get at the lower part of the rear pass.

Tubes over the arch are cleaned by means of a special removable unit. This unit consists of a multiple jet blower element, with one nozzle for each row of tubes. A universal joint of steam-tight design permits easy operation of the unit and insures thorough cleaning of this section of the boiler. The unit is permanently secured to the boiler shell and when not in use can be withdrawn from the tube space out of the heat—a desirable feature in such installations as have temperatures in excess of 2,000 degrees.

Economizer Installations

The same type of units used to clean boilers are now being generally used for the purpose of removing soot and ash deposits from economizers, whether the latter are an integral part of the boiler

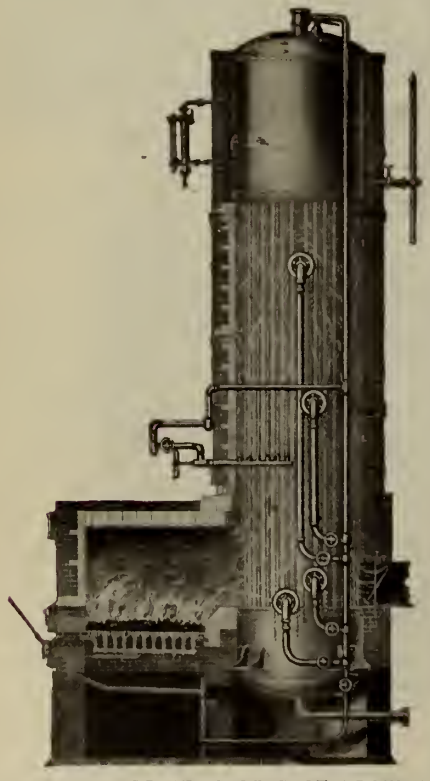


FIG. 5—INSTALLATION OF SOOT BLOWERS ON WICKS VERTICAL BOILERS.

FIG. 6—INDEPENDENT TYPE OF ECONOMIZER EQUIPPED WITH SOOT BLOWERS INSTEAD OF SCRAPER MECHANISM.

or independent units. Fig. 6 shows the method of installation. The arrangement provides for units extending from front to back of economizer centrally located between the top and bottom and spaced four or five rows of tubes apart.

We have stated that soot blowers are going into use on economizers, replacing the old type scraper mechanism. The advantage of soot blowers as compared with the scraper are:

A. Elimination of air infiltration. For every 10 to 16 tubes, depending upon the capacity of the economizer, there is a chain provided for the raising and lowering of the scrapers. These chains pass through holes in the top of the economizer. As these holes are always open, air infiltration is a constant source of loss—a loss which is eliminated when soot blowers are installed.

B. One of the conditions always encountered in some degree in economizer installations is the piling up of soot on the bottom headers. While it is true that a space is provided between the headers which would seem to be ample for the soot to fall through into the soot chamber, yet quantities of it are always building up in the space between the headers and eventually bridging over. As a result the action of the scrapers is interfered with and the efficiency of the economizer is affected by reason of the accumulation. This difficulty is always removed by the use of soot blowers.

C. The scraper mechanism takes from 2 to 5 h.p. of electric power to operate. There is constant charge for power. Scraper maintenance is also one of the most costly features of economizer installation. In addition to the cost of operation and maintenance there is also the handicap of making repairs to the tubes of the economizer. While soot blowers require some operating charges, these charges are very low when compared with scrapers, and in addition the economizer is cleaned more efficiently.

For hollow stay bolt boilers the soo blowers consist of two main pipes fron which extend many branch pipes carry ing Venturi nozzles. One of thes nozzles enters every hollow stay. Th system is so arranged that it clears th hand-hole yokes, permitting them to b removed, and thus making the tubes eas ily accessible for turbining or repair without disturbing the blower in th least. The entire equipment is perman ently installed on the front water leg o the boiler and is operated by two valve only, from the front.

Where boilers are built with horizon tal baffles, a number of the nozzles ar extended over the baffles for distances o from two to eight feet, thus insuring high degree of efficiency in cleaning In addition to the use of blower nozzle extending from the stays, it is at time found possible to equip boilers of thi type with revolving units as well, an this combination equipment offers th most satisfactory method of securin high cleaning efficiency in this type o boiler.

Recent Advances in Design and Con struction

One of the most important recent ad vances in design and construction fron the point of view of increased efficienc is the development of the vertical heade type of installation, Fig. A. This de sign presents many advantages as com pared to the old practice of placing th header in a horizontal position whic may be summarized as follows:

1. Increased effective pressure o steam at blower nozzles, due to the elim ination of a number of right angle joint and the reduction of friction at the fit tings.

2. Permits free expansion of all rise pipes, thus preventing any possible bind ing of the units.

3. Eliminates a number of screw joint with consequent reduction in opportun ities for leakage to develop.

4. This form of construction gives

much less interference with doors, etc., than when horizontal header or right angle joints are employed.

5. Presents much better appearance mechanically.

6. Permits the use of a much shorter header.

7. Valves are concentrated at one point, facilitating rapid operation.

8. Assures thorough draining.

In addition to these special merits, it can be installed as quickly as the horizontal header with its right angle joints, and the cost is, if anything, but little more.

Welded Nozzles

When nozzles of Venturi section were developed, the problem of high velocity as far as soot blowers were concerned was solved for all time. The method of fixing the nozzles in the blower elements, however, has been subject to considerable improvement in the past few years. Originally, nozzles of all soot blower units were simply screwed in

FIG. 7—INSTALLATION OF SOOT BLOWERS ON WATER TUBE BOILER WITH HOLLOW STAYS.

place. Experience showed that the hot gases were continually attacking the threads and that oxidation at this point was much more rapid than elsewhere, with the result that after the blower elements had been in use but a short time the nozzles became loose and in the course of time dropped out, thus rendering the blower element ineffective. To overcome this difficulty, a method of welding the nozzles in place has been developed and is now in commercial use.

The same trouble which developed with screwed nozzles developed with the screwed plugs which were originally used to close the ends of soot blower elments; that is, the gases attacked the threads, with the result that the plugs became loosened and at times blew out. In order to overcome this difficulty, caps were welded on the ends of the blower elements. This construction has, however, recently been modified and greatly improved by placing a disc of steel inside the blower element, then swaging the end, thus partly closing it, and then welding the plug in place, completely closing the end so that there is no possibility of the plug being blown out by the steam.

Probably no feature of soot blower construction has been subject to so much study and improvement as have the bearings which support the units inside the boiler. These bearings were originally made of cast iron, but in the last year a special type of steel bearing has been presented which has innumerable advantages over the old style cast iron bearings. The advantages of the steel bearing are the closer grip on the boiler tube, less transfer of heat, less likelihood of working loose from the boiler tube, etc.

HAMILTON NO. 2 C.A.S.E.

Hamilton Lodge No. 2 held an open meeting on 4th April. Mr. Church, of Toronto, representing Darling Bros., was present and gave a very interesting talk, explaining the slides as shown on the screen. Darling Bros.' steam specialties were the topic of the evening. A vote of thanks was tendered Mr. Church, also Darling Bros. for their kindness in loaning the slides. Hamilton No. 2 is endeavoring to hold up their end of the educational programme. First meeting in May we are having Mr. Parkins, a representative of Canada Metal Co., give us a talk on babbitt metals; also Mr. McDonald, who is at present in Hamilton installing automatic smokeless furnaces. First Monday in June, Coal and Its Origin and Mining of Same, by Mr. S. Gill.

OTTAWA LODGE C.A.S.E.

Ottawa Lodge No. 6 C.A.S.E. held an open meeting in their (St. George's) hall on Thursday evening, April 28, which was well attended. The programme for the evening was a paper on combustion given by Bro. G. I. Scott, chief engineer for the Ottawa Electric Co. Bro. Scott handled the subject with great care to explain the technical points, making the subject clear to all present.

Bro. Scott also gave a lecture on the boiler assisted by Bro. C. V. Clarke, manager Ottawa branch of the Darling Bros. The lecture was illustrated by lantern slides. That the meeting was a success is judged by the number of applications received for membership for the first meeting in May.

Ottawa Lodge is looking forward to the convention to be held by the Grand Lodge in Ottawa on June 27, 28, 29 and 30, which they hope will be a huge success.

They hope to have one of the finest power exhibits ever shown by the order.

LONDON LODGE, C.A.S.E., No. 30

The London Lodge, C.A.S.E., and a number of their friends and relatives held a very successful social evening recently, about one hundred and twenty people being present. The evening was devoted to cards and dancing, and everybody enjoyed it to the full. The London lodge has had a very successful year, the number of new members being twelve. From time to time lectures with lantern slides to illustrate them have been given and these have contributed materially to the interest shown in the lodge.

PERSONAL

J. O. B. Latour, chief engineer for the General Accident Assurance Co. of Canada, has resigned his position and is taking up a similar position with the Employers Liability Assurance Corporaton. Mr. Latour, who is one of the best known engineers in Canada, joined the old Canadian Casualty and Boiler Insurance Co. in the year 1903 as expert engineer and inspector. He remained in that position until October, 1911, when he took over the position of chief engineer, vice A. M. Wickens. In 1916 the Canadian Casualty Co. was taken over by the General Accident Co. and the name changed to the latter company's, Mr. Latour still retaining his position.

* * *

During the intervening years Mr. Latour has seen the boiler business gradually expand until there are now eight companies in Canada carrying these lines. During his connection with the company the revenue from boiler business has increased by nearly 200 per cent. and the staff of inspectors increased likewise. Mr. Latour's many friends in the engineering world will be unanimous in wishing him every success in his future sphere of action and congratulate his new employers on securing his wide experience and undoubted engineering ability. Mr. Latour will be succeeded, we understand, by W. B. Roberts, who has been on the staff for some years. Mr. Roberts is a native of Liverpool, England, and served his apprenticeship to marine engineering at the works of Messrs. Fawcett, Preston & Co., one of Liverpool's famous old engineering establishments. Mr. Roberts served in the Royal Navy during the war, returning to Canada in 1919 with the rank of engineer lieutenant commander. He holds the British Board of Trade certificate of extra first class and has had a wide experience both in the practical and commercial side of engineering. He was chief inspector for Alberta and Saskatchewan for the General Accident Co. for some time, and will bring a good insurance knowledge as well as engineering ability to his new position.

ERROR

In our issue of April 5, answering the question on boiler heating capacity, on page 35, the number 162 degrees should have read 102 degrees.

Vertical Gas Engine for Generator Drive

British-Built Gas Engine Developed For Special Purpose—Comparison of Vertical and Horizonal Engines—Turning Effort And Cyclic Irregularity—Details of the Engine

THE extremely high initial cost of all classes of fuel continues to influence that of iron, steel and other industrial products. Furnace coke, both in its manufacture and again when used in the blast furnace, gives off large quantities of gas rich in by-products and valuable as a means of generating power. The efficient utilization of these gases in large gas engines is a problem which has been neglected in the past. It is only now, when faced with the growing scarcity and high market value of our natural fuel resources, that we begin to consider methods for their utilization to the best possible advantage.

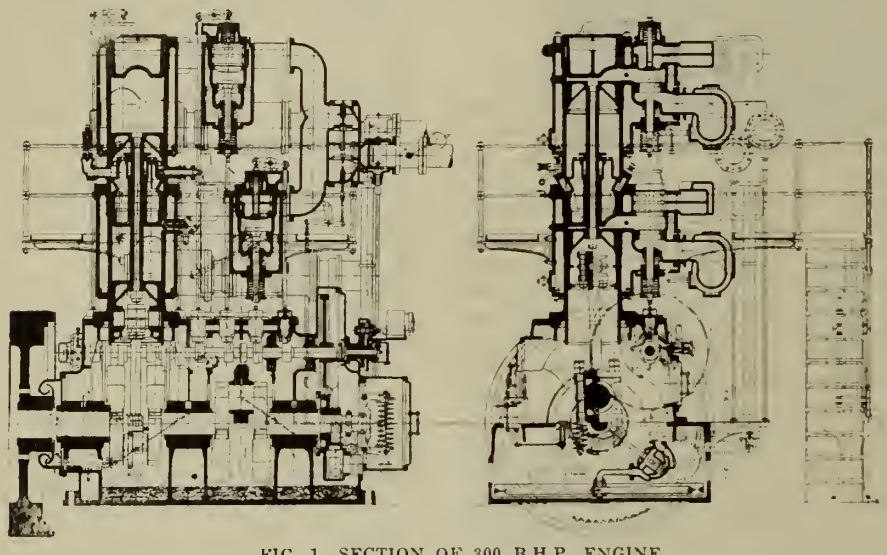


FIG. 1—SECTION OF 300 B.H.P. ENGINE.

During the past ten years marked improvements have been made in gas engine design, with a view to producing a prime mover that will adapt itself to the varying loads required, and at the same time be economical in gas consumption. These improvements are the result of co-operation between some few pioneers of the coal, coke, iron and steel industries, and gas engine manufacturers. The work has been carried out on very practical lines in collieries and ironworks, where there is not a great deal of scope for scientific research, owing to limitations both in the number of staff employed and the expense involved. Valuable data on the subject have been contributed from time to time in papers which have been read before the various societies, etc., from which running costs and general comparative cost figures can be obtained. It is therefore unnecessary to bring these forward here, but rather to explain the development of the existing vertical tandem gas engine.

In the past, when running large gas engines on waste gases, enough importance has not been attached to the maintenance of a constant supply of clean gas at a constant pressure and heat value. These items are dependent to a great extent on the type of ovens, furnaces and cleaning plant employed. To maintain constant pressures the most satisfactory results have been obtained when small gas holders have been employed to control the supply to the engines.

Coke Oven Gas

The greatest difficulty encountered when dealing with coke oven as compared with blast furnace gas has been the fact that the former contains roughly 50 per cent. of free hydrogen by volume and 25 per cent. of marsh gas whereas the latter only contains from to 2 per cent. of hydrogen and no marsh gas. Their calorific values are:

Coke oven gas 420 to 460 B.t.u. per cubic foot.

Blast furnace gas 90 to 100 B.t.u. per cubic foot.

When using a high value gas in an engine it is usual to reduce the compression pressure and retard the point of ignition, in which case the engine governor independently controls the quantity of air and gas required for a given load but has no control over the quality of the gas itself. To overcome this difficulty a special device has been developed by the National Gas Engine Co., Ltd. whereby a quantity of cooled exhaust gas is returned to the engine governor. By referring to Fig. 2 it will be seen that the exhaust gas is mixed with the incoming high value gas around the

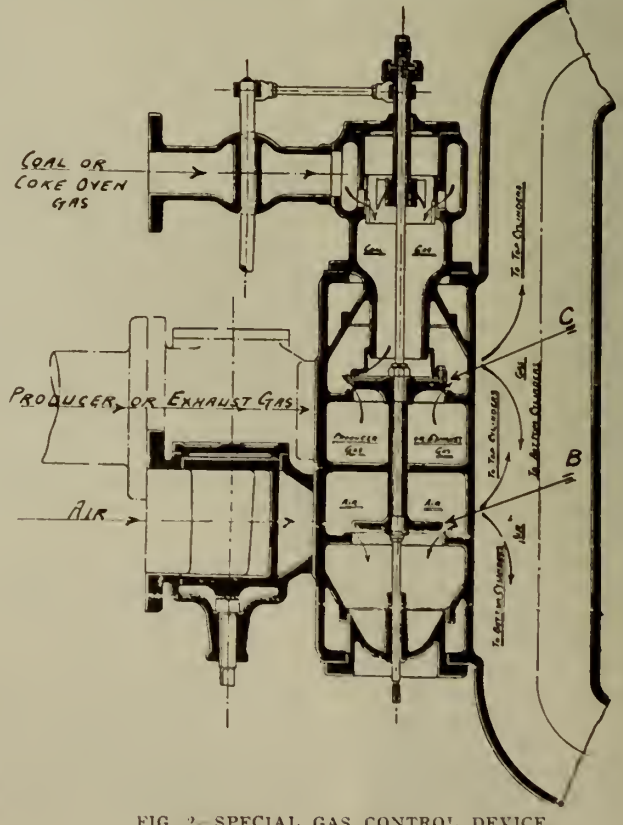


FIG. 2—SPECIAL GAS CONTROL DEVICE.

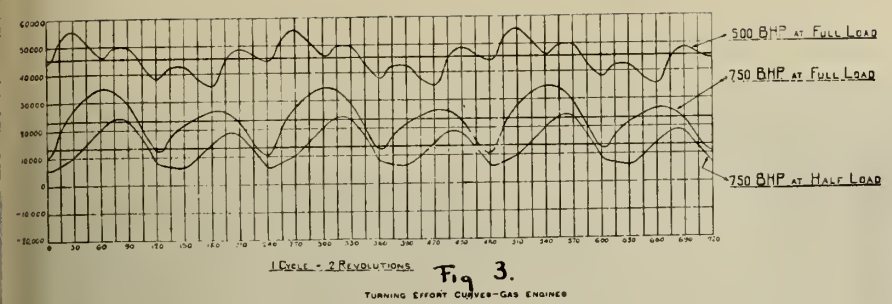
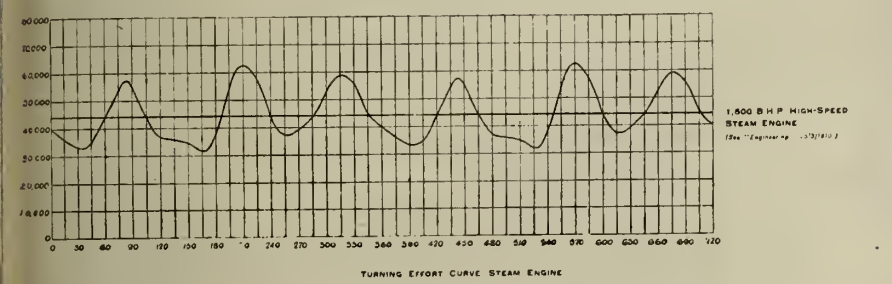


Fig 3.

Turning Effort Curves—Gas Engines



Turning Effort Curve Steam Engine

Fig 4.

throttle valve seat C, independently from the air, which is controlled by the throttle valve B. The heat value of the resultant mixture (i.e., gas proper and exhaust gas) is then say 130 B.t.u. per cubic foot. This reduction in value from 460 to 130 B.t.u. per cubic foot allows the engine compression and ignition timing to be that required for a gas of low heat value such as producer gas.

This type of governor is now adapted to all National vertical tandem engines which are running on high value gases. Since the compression pressure is the same as that required for producer gas, the arrangement can be used as a change-over gear from town's to producer gas, or vice versa, and the change-over can be made when the engine is on full load without any indication of the change on the tachometer or switchboard, when driving an electrical generator. The application of this type of governor shows marked improvement over the standard type of throttle governor using high value gases, both in economy and in the satisfactory running of the engines on varying loads.

Blast Furnace Gas

The use of blast furnace gas for the production of electricity is slowly but gradually becoming adopted. This to a great extent is due to the improvements in design of cleaning plants. The Halberg Beth Dry Filter Plant, although expensive in first cost, will reduce the dust contents of the gas to about 0.001 gramme per cubic metre, which means that the gas is frequently cleaner than the surrounding atmosphere, while large quantities of potash are recovered as a by-product. Wet cleaning plants appear to be giving satisfaction, too, though they do not lend themselves to potash recovery. Electro-static cleaning plants have been in use in England for some time, though for rough cleaning purposes only. A great deal is expected of this method in the near future. It must not be forgotten that the gas must have the existing sensible heat considerably reduced before it can be used in an engine.

Comparison of Vertical and Horizontal Engines

Before proceeding to a description of a vertical tandem engine, it may be of interest to give some of the reasons for adopting this design in preference to the large horizontal type of the same power. One of the chief reasons is the absence of water-cooled moving parts in the vertical tandem machine.

Water-Cooled Moving Parts.—Gas engine pistons, piston rods and exhaust valves for cylinders above a diameter of approximately 25 inches require to be water-cooled. Quite apart from the difficulties in design which exist when allowing for vapor pockets, proper distribution and circulation of the water, complications arise as a direct result of water-cooling, such as the following:

The small amount of space available necessitates the water being of a suitable nature, i.e., it must not contain acid or alkali within certain limits, and efficient arrangements for cleaning must exist in order that the dirt and scale accumulating in the jacket spaces may be removed with comparative ease and in a reasonably short time; the temperature of the cooling water employed must be such that condensation is avoided on the rods and pistons before starting and after stopping; the difficulty of making satisfactory water-tight joints to prevent the leakage of water on to lubricated surfaces, which very often causes serious trouble; and the connection between the internal distributing pipe, to ensure circulation, and the piston rod, is subjected to great stresses on account of the existing forces of inertia.

Weight of Reciprocating Parts.—On large four-cycle double-acting horizontal engines (two cylinder in tandem type) the pistons should not be supported by the surface of the liners, nor the piston rods by the stuffing boxes. To avoid this in practice the rods are turned with their centre lines curved, to compensate for the weight of the pistons. All this weight then falls on the slipper guides. The time required to make adjustments to the working parts of a large horizontal engine is very considerable, due to the fact that these parts are of necessity heavy, and are difficult to handle even with the use of a crane.

Spare Parts.—The cost of spare parts is greater for the horizontal engine than for a multi-cylinder vertical engine, since the latter are standardized and produced in quantity, besides being smaller and more easily handled.

Electrical Generators.—The cost of electrical generators is also greater for the former owing to the difference in engine speeds, the one being run at 80 to 90 r.p.m., while the vertical engines run at between 200 and 300 r.p.m.

Turning Effort and Cyclic Irregularity

Parallel Operation of Alternators.—All alternators have a natural periodicity, depending upon the electrical design of the machine and the load to which it is subjected, and it is essential that deviation from perfect rotation should not exceed 2½ to 3 electrical degrees. It will be easily realized therefore that for an alternator with a large number of poles the permissible fluctuation is much more limited for a slow speed than for a high speed machine. The torque diagram of a steam or gas engine can always be represented as a series of waves irregularly formed, but nearly

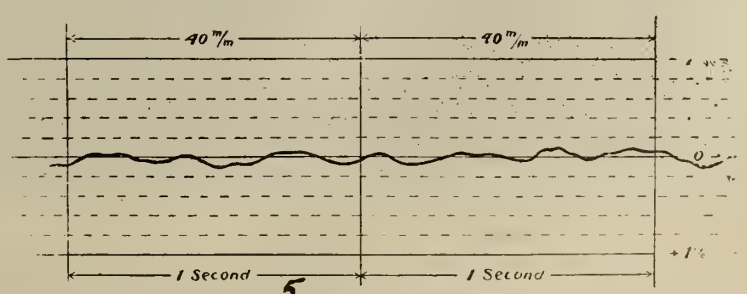


Fig 5 Tachograph Curve.

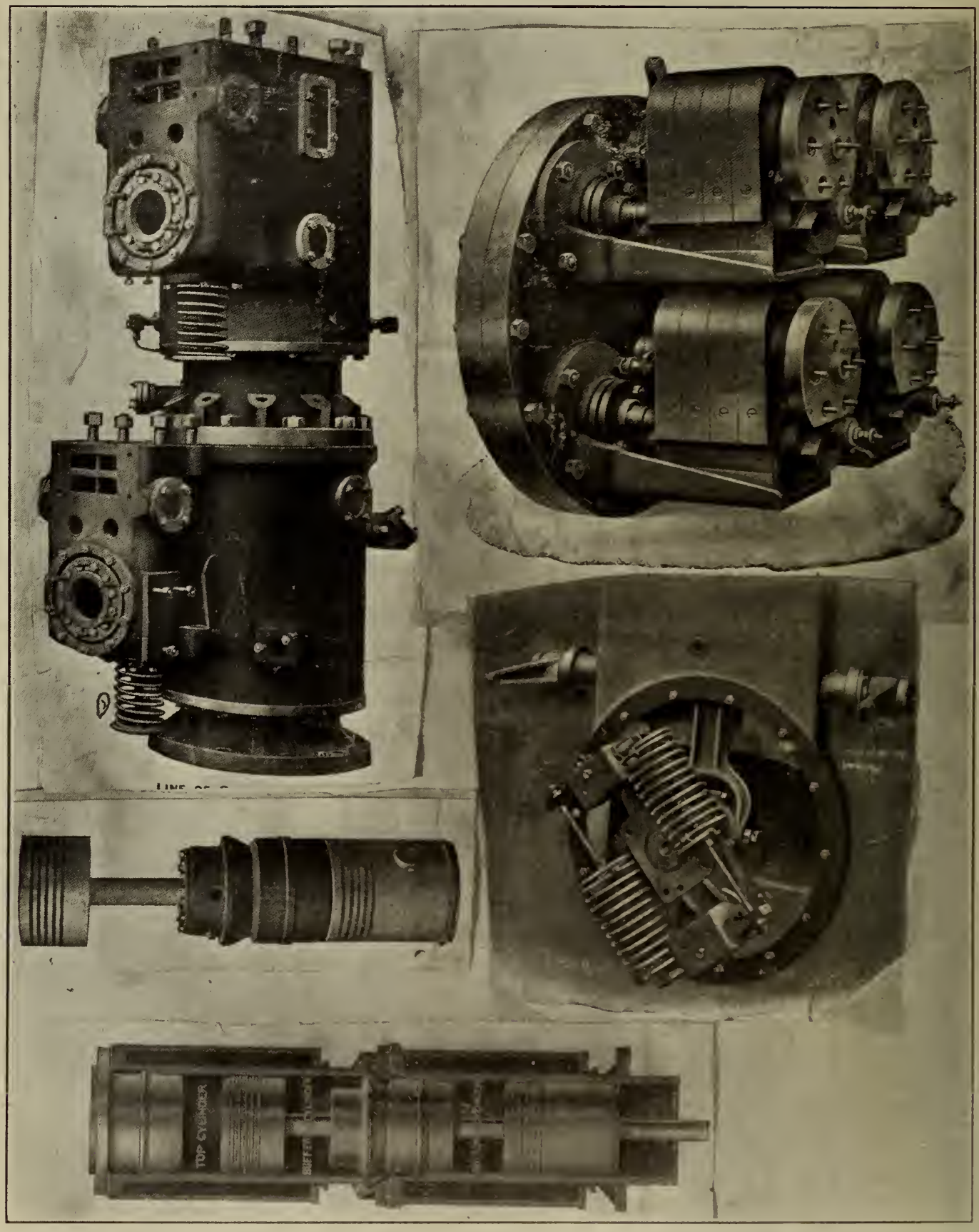


FIG. 6—CYLINDERS IN TANDEM. FIG. 7 SECTION OF CYLINDERS. FIG. 8—TOP AND BOTTOM PISTONS. FIG. 10—GOVERNOR. FIG. 11—IGNITION.

regularly repeated at constant intervals. (See Figs. 3 and 4.)

The impulses per revolution are, of course, the main factors that determine the flywheel effect if the flywheel is laid out for any standard cyclic irregularity.

If we consider the time of one or two revolutions as a fundamental period it is found that in all well-balanced reciprocating engines harmonics exist depending for their order upon the number of cranks of the engine. The value of the harmonics, although they exist, can be almost entirely ignored as far as hunting is concerned. The important fact is that, unless special precautions are taken, a fundamental wave will exist.

The National vertical tandem engines are designed, when required for alternator work, to have a cyclic irregularity of 1/250. Sufficient flywheel effect is allowed for in their design to easily cover this, and at the same time be

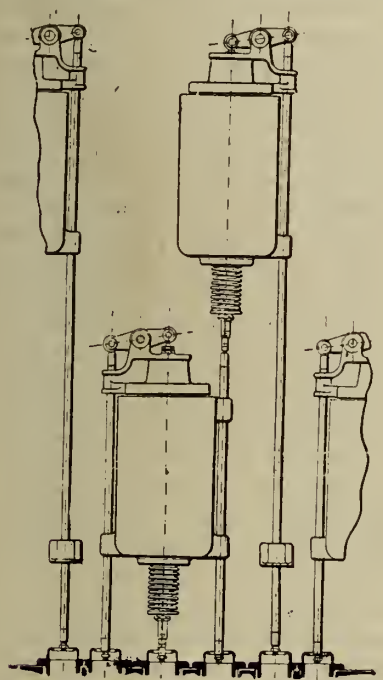


FIG. 9—ARRANGEMENT OF VALVES.

within the limits of 2½ electrical degrees from a standard flywheel. This is very much easier to do with a high speed than with a low speed alternator. Fig. 5 represents a tachograph curve from a vertical tandem engine, from which it will be seen that the cyclic irregularity, taken over the extreme points on the curve, is approximately 1/500.

The "National" Vertical Tandem Gas Engine

For the purpose of description and illustration a sectional arrangement of a 300 B.h.p., 2-crank, 4-cylinder engine is given in Fig. 1. The larger units, except in detail, are similar to this in design. The engines are built in standard sizes from 300 to 2,000 B.h.p., with 2, 3, 4, 6 or 8 cranks. They operate on the "Otto" four-cycle principle, and each pair of cylinders is arranged in tandem over one crank. (See Fig. 6.)

Cylinders.—A difference in diameter is made between the bore of the top and bottom cylinders, sufficient to allow of a cone seat being made in the top of the lower cylinder. The intermediate head or cover for the bottom cylinder makes a joint on this and is secured by "pole-screws" passing through the flange of the top cylinder on to an angular face around the intermediate head. (See Fig. 7.) A similar joint is made by the top cylinder cover.

Pistons. (See Fig. 8.)—The pistons, both "top" and "bottom," are secured together by means of a bolt of chrome nickel steel passing through a hard cast iron piston rod sleeve. This sleeve acts as a distance piece transmitting the thrust of the top piston to the lower piston, the steel bolt taking the tensile stresses. After being assembled the necessary working clearance is given to the line of pistons in the grinding machine.

Operation.—The tandem arrangement of pistons with an explosion on the top of the upper and lower pistons alternately, together with the number of cranks, gives an even turning effort. Smoothness of running is also the result of cushioning on every "up-stroke," by the compressions of the mixture taking place alternately in the top and bottom cylinders, and on every "down-stroke" in the spaces between the top pistons and intermediate heads. Metallic packing for the piston rods is secured in the top of each intermediate head. The packing is surrounded by the water jacket of the head and is supplied with lubricating oil under pressure.

A line of pistons, consisting of top and bottom pistons secured together, intermediate head and connecting rod, can be withdrawn for inspection and cleaning after removing the top cover, securing nuts and pole screws, water connections and crank head nuts. The whole is withdrawn through the top cylinder by securing a clip to the top piston.

Operation of Valves.—The inlet valves, in their respective cages, are secured in positions directly above the exhaust valves, and in order to give ease of access the valves in the top cylinders are "staggered" in relation to those in the bottom cylinders. (See Fig. 9.) This arrangement allows of a direct lift from above, thus facilitating their removal for inspection. The valves are operated by push rods and rocking levers, the exhaust valves being arranged vertically over their respective cams.

Governor.—The engine is controlled by a centrifugal governor mounted on the crankshaft (see Fig. 10), which controls the quantity of mixture admitted to the cylinders. Mixture of "gas" and "air" does not take place until the inlet valves open in the cylinders, the two being governed independently, and entirely separated from one another by a division in the manifold induction pipe.

Lubrication.—Lubricating oil is drawn from strainers in the bedplates, each lying in its own trough, into which the oil flows as it drains back from the crank pits. By this means the bulk of dirty oil is isolated from the strainers. The strainers can be withdrawn one at a time without interfering with the running of the engine. A valveless double acting pump delivers the oil at a pressure, which can be regulated, to the oil cooler and engine bearings. The oil supply to the crank head bearings passes through holes drilled in the crankshaft to the crank pin and up through the centre of the connecting rod to the piston pin. For a large installation of more than one unit, or a single unit of 1,000 k.w. and above, the pump, strainers and coolers are separated from the engine and become an auxiliary motor driven unit along with the water circulating pumps. Sight feed lubricators supply clean oil to the top cylinders and piston rod packings.

Ignition.—The electric ignition is in duplicate. Low tension magnetos with high tension coils, connected to each, supply the necessary current. The left-hand magnetos supply the left-hand ignition plugs in each cylinder respectively, and change-over switches on the coils allow of battery ignition being used as a standby.

Starting Gear. — Compressed air is used in the bottom cylinders only for starting the engine, suitable timing, stop and check valves being employed for this purpose, so that no hand movement of cams is necessary when starting the engine.

FORCING HOME A PISTON HEAD

A nut that came off inside the cylinder brought us the job of making a new rod and piston. We made a splendid fit of these but we had no good way of getting the head clear up to the shoulder on the rod. There was no press within fifty miles and we knew that we would injure something if we used the 24-lb. sledge as a "persuader."

Finally we jarred the head on. It was already within an inch of the shoulder and we turned the assembly, head in the air, resting the cross head end of the rod on a piece of 3″ x 12″ maple plank. A length of rope to the roof truss prevented it from toppling and acted as a safety. A foot of 4″ pipe secured to the plank guided the lower end. Then four good men lifted the job about 6″ at a time and let it drop, soon getting the desired position with this 200-lb. head.

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Finding the Easiest Way

ALTHOUGH we have on occasion specifically stated that we cannot furnish actual examination questions and answers, and that we would not if we could, we still receive letters from correspondents requesting just this very thing. Therefore it seems incumbent upon us to once more state our position in this matter.

Power House is a paper for stationery engineers, and as such is willing at all times to help out engineers who have definite problems of a technical or practical nature arising in their daily work. There is one department of the paper open for this purpose under the heading of "Our Question Box" and there is no restriction on the type of question that may be asked, and every effort will be made to provide a correct answer. There is also the "Course of Instruction" which has been running for some time, and it is definitely designed to help engineers who are about to sit for examination. It gives this help by teaching the principles of the subjects that will form the examination, and not by attempting to give specific answers to specific questions. The columns of the paper are always open for correspondence between engineers who have different points of view on any question. When it comes to a matter of procuring the questions that the examination board use in their work, and furnishing these and the necessary answers to candidates who are too lazy to get sufficiently acquainted with their business, and at the same time wish to take a dishonorable advantage of those who have worked and studied to fit themselves for examination we draw the line.

We think perhaps it would be a good thing to forward the next request of this kind that we receive to the examining board, so that they could be on the look out when the seeker after knowledge came up before them. They could then make very sure that the candidate did not have the answers to the questions that were asked. Once more we ask, what good would it do a man to pass an examination in that way, and know himself for ever after as the worst type of what is called colloquially a "four flusher?"

What Are Long Hours?

AT the present time when it seems to be the general aim to reduce working hours to the last possible minimum, consistent with doing any work at all, we often wonder what the power plant engineer thinks of it all. The average man in charge of a power plant works longer hours than probably any man outside of a power plant thinks about, and as a general rule he does it without complaint, and with a ready cheerful spirit. On holidays, a good many Sundays, and Saturday afternoons, when every one else is away, the power plant engineer must be on the job, so that the factory can start up on time to allow the working men to get in their 44 hours or 48 hours as the case may be. If it is a small factory and a small plant where perhaps only one engineer is employed, his hours are bounded usually by his capacity for going without sleep. He keeps the plant going during the day, looks around after the plant shuts down to several little jobs about the boiler room, engine room and factory that must be attended to right away, and leaves off not at any particular hour, but when the jobs are all done. Saturday afternoon and Sunday he devotes to major repairs, and odd little jobs like washing out the boiler, etc. The rest of the time is his own. We remember a case where a long suffering engineer got a job in a hospital. As usual with hospital jobs, the hours were long, and the pay was slightly less than the usual rate, but our friend recognized that times were a bit dull and therefore contented himself, and labored long and faithfully to make the plant as good as possible. One night after he had put in a particularly hard spell for the previous fourteen hours, he had his clothes changed and was all ready to leave for home, when his phone bell rang. Answering the call a polite voice requested him to kindly step up and give them a hand to carry out a body, the orderly who usually helped in this being away. The long-suffering engineer answered this request by the statement that for the future he would be away too, and went sadly away to find a job where removing corpses was not included in the daily routine.

This of course is perhaps an extreme case, and generally the tendency is to make the power plant engineer's working time more reasonable than it was, but still we do not seem to have heard any outcry from engineers for the unreasonable things some tradesmen seem to be after. The stationary engineer as a rule has enough interest in his job and his own reputation to make him willing to give a few hours' extra work without making much fuss about it.

LEADING ARTICLES IN THIS ISSUE

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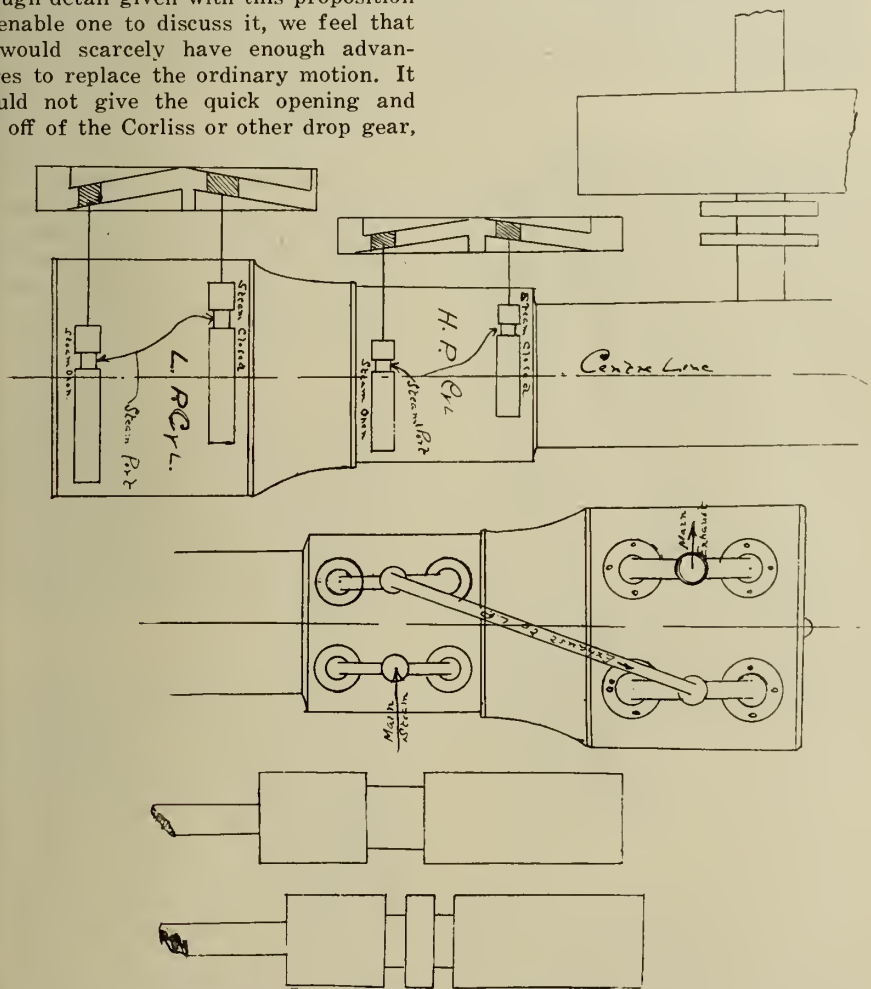
The Operators' Point of View

A NEW VALVE AND MOTION

The sketches here shown have been submitted by a reader of Power House who has a number of original ideas to his credit. While there is scarcely enough detail given with this proposition to enable one to discuss it, we feel that it would scarcely have enough advantages to replace the ordinary motion. It would not give the quick opening and cut off of the Corliss or other drop gear, and as against the ordinary slide valve it would have more moving parts and more sliding friction as compared to the rolling friction of the ordinary valve.



UPPER VIEW—ARRANGEMENT OF VALVES AND MOTION. LOWER VIEW—SINGLE AND DOUBLE PORTED VALVES.

Mr. Walsh, the originator of the gear, is chief engineer of the Dominion Coal Co. at Port au Port, Newfoundland, and the following is his own description of his idea: "You will note that this valve and motion is of the sliding type, thus doing away with the half rotary and wrist pin motion. The H.P. admission motion is worked from a fly wheel governor to give early cut off under light loads. The motion is carried on a table or carriage, which has a channel cut in it. The wedges or inclines are fitted in this table, and adjustment made by set screws. The carriage itself travels in a V-shaped groove similar to the bed of a lathe or planer. The valve shown is a single ported valve, with exhaust arranged to take place between the end of valve and the cover. There is a steam tight collar on front end which is meant to reduce the pressure on packing. The valve spindle is made heavy on account of the bending motion due to the side travel of block. The spindle is connected with a toggle block. When the motion moves the block travels path of incline, thus moving spindle in or out. I think the device would make a very positive action. You will note that each cylinder has two valves and each valve has its own steam and exhaust independent of the other valve. Thus each valve attends to work of piston for the full length of stroke."

SOME MORE COMMENT

In the Power House of March 5th you ask for some comment from your readers on the perpetual motion compressor described by H. Nicholaides in that issue.

According to Mr. Nicholaides he has had technical men reviewing his discovery, and has obtained an "action" from the Patent Office, whatever that might be.

Being a youngster in the engineering profession, the writer would like to see this mysterious machine which shows an efficiency of over 100 per cent. "shown up."

It is contrary to the teaching we are getting from our tutors and text books.

No doubt there will be lots of comment on the Californian's article by technical men, but we will try and let you have a fourth class steam engineer's view of it.

In the first place let us consider a well-known cylinder used for compressing air, a common automobile tire pump.

By depressing the handle and incidentally the leather washer or piston, the air at atmospheric pressure below the piston is reduced in volume, and according to Boyle's Law, which our friend has frequent recourse to, the pressure in the cylinder is raised inversely as the volume.

This can be sensed by the increasing force required to depress the handle as the stroke continues.

At ¼ stroke the pressure in the cylinder will be raised inversely as the volume and become 15 lbs. (atmos.) times 4-3, the latter figure being 3-4 inverted, this is equal to 20 lbs. absolute, which is 5 lbs. above atmospheric.

At half stroke the pressure will be 15 lbs. and so on until the tire pressure is reached when the pressure on both sides of the tire valve is balanced. Then by still depressing the handle the pressure is raised enough to overcome the valve spring and the charge of compressed air enters the tire.

Although the pressure, when the valve opens, it, let us say, 70 lbs. per sq. in., the average pressure on the piston may

not have been higher than 25 lbs. per sq. in.

Supposing the pump cylinder to be 1 sq. in. area and the stroke one foot, then the work done would be around 25 ft. lbs., and not 70 ft. lbs., as Mr. Nicholaides would no doubt figure.

From the foregoing we can see that the same results can be had with one cylinder of 8 ft. stroke as with a fantastic battery of 8 cylinders, each having a stroke of one foot.

In figure 1 is shown a steam cylinder B, and an air cylinder A, directly connected. Just as soon as the piston is caused to move downwards the air in A is reduced in volume, and its pressure is therefore increased, so that some force is required to overcome this increase in pressure.

Both pistons are assumed to have an area of one sq. ft., so an increase of 1 lb. for sq. in. of air in A will need a similar increase of steam pressure in B to effect the continuation of the stroke. All of this is neglecting friction, of course.

As the pistons descend the pressure in the air cylinder increases until the point e is reached, which is 10-11 of stroke theoretically. At this point the air is reduced to 1-11 of its original volume, and in accordance with Boyle's Law again, we get an absolute pressure of 15 x 11 = 165 lbs. per sq. in., or 165 — 15 = 150 lbs. per sq. in gauge pressure, which is, roughly speaking, 10 atmos.

At this pressure the discharge valve opens to the receiver, the pistons complete the stroke and "the cubic foot of air is found compressed to atmosphere in the reservoir!"

Figure II is a theoretical diagram of what takes place in the air cylinder. XY is zero, and AB represents atmospheric pressure. (In this case 15 lbs.)

The stroke commences at (a) and as the piston descends the pressure is indicated by the curve until (e) is reached when the pressure is 150 lbs., and remains so until the end of the stroke (b).

The average height of the pressure line can be found by dividing the area of the figure a e_1 b_1 b e by the length a b.

From this we get the mean effective pressure on the air piston, which is, roughly, around 35 lbs. per sq. in.

The average total pressure on piston times the stroke in feet gives us the work done per stroke, in this case, 35 x 144 x 1 = 5,040 ft. lbs.

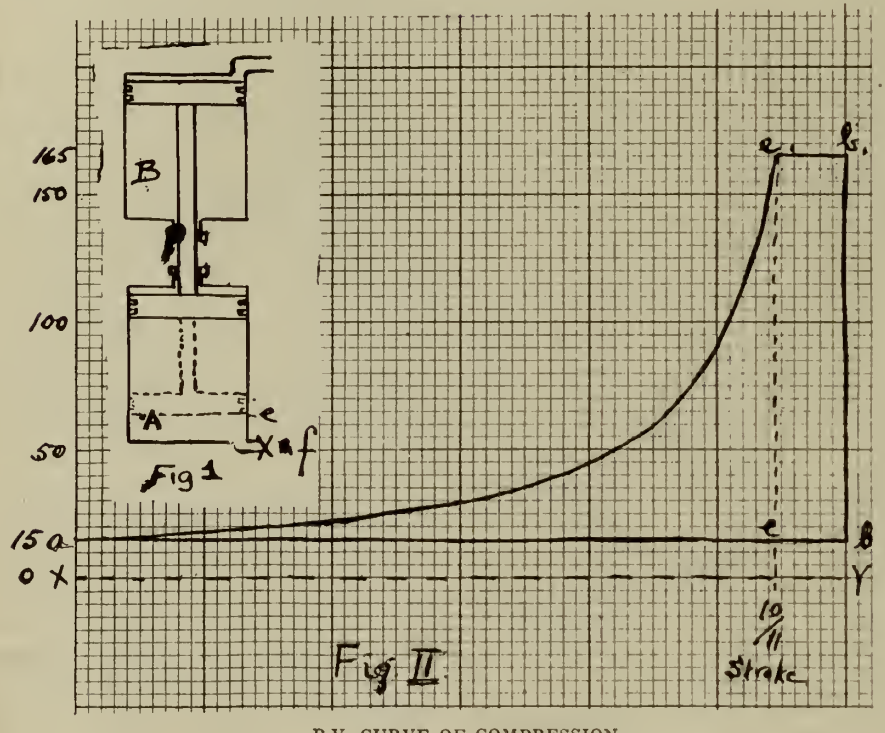
The work done in eight such strokes = 5,040 x 8 = 40,320 ft. lbs., and not 172,800 ft. lbs., as Mr. Nicholaides would have us think.

Presumably he imagines that 150 lbs. per sq. in pressure is required on the steam piston during the whole of the stroke. Nothing is more absurd.

As a matter of fact, with steam at 150 lbs. and counting all losses an engine cutting-off at 1-3 stroke would drive the air piston comfortably.

Our friend by frequently employing his "scientific calculations" finds the ultimate total pressure on a bunch of pistons, adds them together and calls the sum the amount of work in foot pounds done in the cylinders.

I hope I have not trespassed on your time unduly, Mr. Editor, and hope to read more able comment from other contributors.



P.V. CURVE OF COMPRESSION

ANNOUNCEMENT

The sales management for Riley Underfeed Stokers and Murphy Furnaces has been concentrated under one head William Pestell, formerly Western sales manager with headquarters at Chicago now becomes sales manager with headquarters at 1226 Woolworth Building New York city. W. L. Bigelow becomes district manager of the Pittsburgh territory, while C. Lincoln Smith goes to Cincinnati in the same capacity.

To better serve the territory in and around Kansas City, the F. M. Beeson Machinery Co., 308 Mutual Building Kansas City, Mo., have been appointed sales agents for both Riley Stokers and Murphy Furnaces.

Sales in Denver territory will be handled by Stearns-Roger Mfg. Co., 1718 California Street, Denver, Col.

The Boston, Buffalo, Cleveland, Detroit, Chicago and St. Paul offices remain as heretofore.

The Homestead Valve Manufacturing Co., Inc., have made some additions to their New York sales force. Mr. N. A. Althouse and Mr. E. V. Curran have joined the staff and will be attached to the office at 242 Lafayette Street, New York City.

We have received the booklet just issued by the Allen General Supplies, Limited, Toronto, describing the various lines handled by this firm. This includes water softening and filtration plants, boiler feed regulators and pump governors, Venturi meters, feed water heaters, etc. The various lines are well illustrated and described.

We have received from the H.S.B.W. Cochrane Corporation, Philadelphia, a very useful book on boiler room problems. The volume is entitled, "Finding and Stopping Boiler Room Wastes," and contains over 400 pages. The contents include Fuels, Combustion, Boiler Efficiency, Heat Absorption, etc., and all these subjects are treated very fully and are very well illustrated. The book has been compiled and edited by George H. Gibson and is published at $1. It is bound in cloth covers, and is well worth a place in the office of any chief engineer or power plant superintendent who requires a book for ready reference on any of the subjects included.

The successful contestant this year for the gold-headed cane annually presented by the Montreal Harbor Commissioners to the captain of an ocean liner first bringing his ship to the port goes to Captain Michael Doyle, of the Cunard freighter Venusia, which arrived last Thursday night from London.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

CAPACITY OF AIR COMPRESSOR

Question:—How do you figure the capacity of an air compressor marked 12 x 12, speed 200 r.p.m., air pressure 100 pounds per square inch?

(2) What percentage of ash should there be in coal?

(3) Would you divide ash by coal or coal by ash?

Answer:—The capacity of an air compressor is calculated in cubic feet of free air per minute. If the cylinder is 12 inches diameter by 12 inches stroke, each stroke draws in a volume of air $1 \times 1 \times .7854 \times 1$ or .7854 cubic feet. If the compressor is double acting the piston displacement per minute will be $.7854 \times 400 = 314.16$ cubic feet, and this is the amount of free air the machine would handle, neglecting losses.

The percentage of ash in coal varies very widely from 5 per cent. in the best bituminous or semi-bituminous steam coal, to as high as 20 per cent. or 25 per cent. in some grades of anthracite.

The percentage is found by dividing the weight of coal into the weight of ash and multiplying by 100. For instance, if we have 2,000 pounds of combined coal and ash and 400 pounds of it is ash the percentage would be $400 \div 2{,}000 \times 100 = 20$ per cent.

QUESTION ON LOAD FACTOR

Question.—In reading a recent issue of the Power House I was much interested in the article, Effect of Load Factor on Station Cost. However, I did not fully understand your explanation of the term "Load Factor," as I have been instructed the way to determine the load factor of a power unit is the ratio of the full capacity of unit to the indicated load, i.e.: If capacity of unit is 500 kws. and indicated load is 100 kws., then l.f. would be 20 per cent., and to get average l.f. take ratio of capacity of unit to the average No. of kws. for any given period, i.e., average No. of kws. for 24 hrs. = 50 kws., then average l.f. would be 10 per cent., also to get maximum l.f. with capacity of unit at 500 kws. and maximum load 300 kws., then maximum l.f. would be 60 per cent.

Would appreciate the favor very much if you would kindly let me know if I am in error and explain proper method giving an example in figures.

Answer.—If you were discussing load factor as related to the output of a machine as compared to its full capacity (rated) the method you describe would be quite correct. However, as explained by the author of the article in question, load factor as used to determine capital charges on an investment is the number of kilowatt hours of output as compared to the possible number of kilowatt hours based on an average demand. For instance, in Fig. 4 of the article in question, the chart for Monday shows practically no load from midnight till about 6 in the morning. The load then jumps to 10,000 kw. till noon, when it drops again till just after one o'clock, and drops again from 6 till midnight. If the demand be taken as an average of 10,000 kw. during the normal working period, then the total possible output would have been 10,000 x 24, or 240,000 kw. hours. Actually the output is only a little over half of that, or 54 per cent. as shown by the chart. Now take on the holiday the demand on that day is low, but the curve is very flat, that is the average load or output approximates fairly closely to the maximum. Thus the load factor on that day is higher than on the working day. If the load factor was based on the capacity of the station it would have the effect of making the load factor very low on holidays and Sundays, while in this case it is just the opposite.

A PECULIAR ACCIDENT

A rather unusual accident is reported in a contemporary as having occurred to a turbo blower set. It having become necessary to change over from one set to another, the engineer in charge signalled to his assistant to shut down the first machine as the other took the load. This was done, but the assistant neglected to close the valve in the blower discharge, with the result that the air pressure in the main drove the closed down set in the opposite direction. The lubricating arrangement which would only operate in the natural direction, failed to give any oil to the bearings and in a short time they warmed up and seized.

BOOK REVIEW

We have received a copy of a book issued by the De Laval Steam Turbine Co., Trenton, N.J., entitled "Ten Years' Progress in Water Works Pumps," dealing chiefly with the development of pumping station units. The opening pages of the book are devoted to a discussion of the economies of different types of pumping engines, and are divided under headings including "Adaptability," "Duties Developed," "Pumping Costs" and "Capital Charges," and these subjects are illustrated by curves. There are also curves showing cost of steam under different conditions. A long list of municipalities which have adopted the De Laval centrifugal pumps follows, and a large number of installations are illustrated. A most interesting portion of the book is that dealing with the testing of steam turbines and centrifugal pumps and the methods of measuring head and discharge capacity. Some interesting data on orifices and nozzles are included. In compiling this data the author has made a very exhaustive search through all the literature published in English, German and French, and is probably the most complete ever assembled in this form. The book is handsomely turned out and should be of great value to any engineer interested in these problems.

The Crane Packing Co., 1800 Cuyler Avenue, Chicago, U.S., have published a book on "Metallic Packing" dealing with its development uses and correct application to modern equipment. While the book is frankly a catalogue of John Crane packings, it is also full of useful information on a subject which is very interesting to every engineer. Practically every form of service to which packing can be put is treated, and a number of interesting illustrations are included.

The Dominion Steel Products Co., Ltd., of Brantford, announce that they have taken over the sole agency in Canada for the Darling (patented) compression hydrant, and these hydrants will be manufactured at their plant in Brantford. The Darling hydrants are manufactured in the United States by the Darling Valve & Mfg. Co., where they also make the Darling (patented) gate valve. This valve, as well as the hydrant, will be in future manufactured for the Canadian trade in Brantford.

Telling The Story of Oil*

THE throne of King Coal in the world of industry and commerce is rapidly being usurped by his royal brother, King Petroleum. Royalty is becoming scarce in the regeneration of nations, and these royalties are not an exception, though to retain them is the earnest desire of everyone. Commerce depends upon transportation and industry, and both of these depend upon fuel. Never has there been such a demand for oil. With the derivatives of petroleum we run our airplanes, automobiles, motor trucks, and with it as a direct fuel we are beginning to furnish steamships, railroads and factories with the power to keep them at work.

This huge demand for oil has drawn greatly on the natural resources of the earth's limited supply. It is estimated that in 1921 there will be twelve million automobiles in the United States, requiring 430,000,000 barrels of petroleum to hold the fuel gasoline at a fair proportion to supply the demand. Since 1911 the number of automobiles has increased ten times, while the increase of oil production in this country has increased but one and two-thirds times. The increase in cars for 1920 equals 32 per cent. over 1919, while the oil increase is but seven per cent. Comparing the demand for oil during a four months' period of 1920 with the available supply for the same period, it is found that there is a draw upon our surplus equivalent to a deficiency of a 56-day supply. It can easily be seen that something must be speedily done to combat these conditions. New oil wells must be opened and new methods must be discovered to attain greater efficiency in getting the oil from the earth, as well as more economic conditions of refinement. It is stated that only about twenty per cent. of the oil is taken from the ground in any well; eighty per cent. is left in the ground because we are unable to get it out. This is the problem for engineers to solve.

There are two widely differing opinions as to how the oil originated in the surface of our planet. Chemists have been able to make many of the derivatives of petroleum in the laboratory by following the principles of what is known as the "chemical theory" of the origin of petroleum. Under heat and pressure the chemical compounds of hydrogen and carbon have produced some of the by-products which can be obtained from crude petroleum, but on a commercial scale the process involves too great expense to be of economic value at present. When all the oil has been taken from the ground, then perhaps some method of synthetically making the necessary by-products of petroleum will be found.

The second theory, that held by geologists, is that petroleum was formed in the rock in a manner somewhat similar to the formation of coal. From organic bodies, both plant and animal, living in the remote past came the various grades of oil found in broadly scattered areas of the earth. The heat energy of decaying vegetable matter, as well as that of animal organisms, was preserved in the sealed pressure-chambers of the rock. This stored-up energy of the early days of life on the earth now furnishes the fuel for factory and steamship, airplane and automobile. Whether of inorganic or organic origin, Father Time hoarded the treasure of oil in his vaults beneath the ground, and to-day we are taking out the treasure without the means of replenishing the supply.

A modern oil refinery is one of the most interesting places for a layman to visit. If he intends making a thorough inspection of the industry, he really ought to begin his journey at the wells. The United States is the greatest source of oil in the world at present, though Russia promises to again take the lead. Mexico, the East Indies, China, South America and other countries also contribute to the world's supply. The petroleum from different localities differs widely in quality, and often there occurs a variation in exceedingly narrow limits of territory. Indeed, the grade of oil from a single well may change its character to a surprising extent. The methods of purifying or refining all these varieties of crude oil must necessarily differ in details, and the general plan of refining the crude petroleum serves merely as an outline of the many processes. Only the common skeleton will be described here, and the methods used in one refinery will often be found considerably modified compared with the conditions of another.

When the first oil wells were drilled in this country the manner of conveying the oil to the places best adapted for its refining was a great problem. It was hauled in barrels in carts, transported in tank cars, and finally piped from the well to the refinery. Thousands of miles of pipes now connect the oil wells with the localities best adapted to treat the oil and remove its impurities, its bad odor, and reduce it to the various factors required in its widely differing uses. From the oil must be taken gasoline to run automobiles; kerosene to be used in lamps and heaters, and for operating certain types of internal combustion engines, and finally what is known as "paraffin distillate," from which lubricating oils are obtained.

There are distinct processes of refinement. Each depends upon the amount of a certain product to be obtained as well as upon its desired quality. The crude oil is subjected to gradual heating, and the vapors given off under the distinct variations of increasing temperature are condensed and further refined. This process is technically known as fractionization. Crude petroleum heated in a crude still first gives off its lighter oils, those which evaporate at low temperature. Like water, oil evaporates slowly when exposed to the air, the more volatile substances of which it is compounded being easily lost. As the temperature is raised, heavier substances are turned into vapor, and so on, until finally only coke remains as a residue in the bottom of the still. It can easily be seen that when heat is applied to a still containing crude oil, not only its lightest vapors immediately are given off, but some of those farther down the scale of weight, or specific gravity, manage to escape with the lightest ingredients. This necessitates further distilling the lighter oils, until finally the heavier substances which have escaped with them are collected. It is unnecessary to say how important is the use of temperature measurement in the distillation of the petroleum. Not only must the color of the oil be watched at the still to indicate the grade of oil that is coming off, but the most precise observation of the temperature of the fires under the still must be observed. Tycos still thermometers figure prominently in the whole of the refining processes. In fact, they find a place along the pipe lines, because the temperature of the oil while being piped to the still is necessarily observed at certain pumping stations during the changing seasons of the year.

After the various "fractions" of the crude oil have been obtained, the refined oil distillate, the naphtha, and the paraffin distillate receive chemical treatment to remove impurities, the sulphur, and to improve the color and odor of the oils. This chemical treatment consists first in agitating the oil with sulphuric acid. After this agitation there settles in the bottom of the oil a heavy mixture, the tar-like material which was held in suspension. This material is further treated and separated into three layers. The top layer consists of acid oil, the next layer of acid tar, and a layer of weak acid at the bottom. The middle layer of acid tar may be used for its asphalts or burned as fuel. After this treatment the

* Tycos-Rochester

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The correct weight shows instantly as soon as the load is moved on to the platform, in plain figures on a big dial.

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Fairbanks Dial Scales

are self-contained, all metal, strong and durable for constant service. Suspended platform construction means that all jars and vibrations are absorbed by suspension members before reaching bearings and pivots.

The dial may be furnished with double face to read from either side and an extended beam may be provided to increase the total scale capacity.

This is but one of the many Fairbanks Scales. There is a Fairbanks Scale for every purpose. Write our nearest sales office for any information you may require.

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		Vancouver	Victoria	

Fairbanks-Morse

oil is further purified by filtering it through clay.

So much for a brief outline of some of the fractionization methods employed in the oil industry. What is known as "cracking," a process which actually splits or cracks the molecules of the oil by means of intense temperatures under pressure, refinement to produce materials of certain quantity and quality are obtained. It is estimated that refiners can get two times the amount of gasoline from crude oil by the new cracking methods employed, giving 35 per cent. compared with 12 to 22 per cent. obtained by old methods. In this process the matter of exact temperature control, as well as pressure regulation, is of vital importance. Raise the temperature in a still to a high degree and the heavier substances as well as the lighter are turned into vapors which can be condensed into the derivative desired. The processes, however, vary widely according to the kind of oil that is handled, and each is calculated to suit the particular grade of substance with which it must deal. The crude oil produced in this country is a fair representation of the world's petroleum; it contains spirits, oils and solids. After being filtered through animal charcoal to remove mineral particles held in suspension, the oil is sent to the stills, which may be worked in batteries of three or more, each handling 24,000 gallons.

Fractionization, in which the volatile spirits are removed by a temperature between 100 and 125 degrees F., and followed by taking out the light oils at a temperature between 215 and 230 degrees F., producing kerosene and paraffin, is usually first employed. Further heating causes the heavy oils to come off. These, redistilled under a pressure of 250 pounds to the square inch, start the "cracking" process.

Water, at atmospheric pressure, boils at 212 degrees F., but if it is placed in a closed container and the surrounding pressure is raised to 150 pounds a square inch, then the temperature must be raised to about 366 degrees F. to make the water boil. The boiling point of a liquid is merely the temperature at which its vapor pressure equalizes the external pressure upon the liquid. The comparison applies to oil. With a high pressure it is possible to obtain the high temperature necessary for rapid cracking, preventing at the same time much of the lighter substances from distilling over. When a temperature of 700 to 725 degrees F. is reached the rate of cracking becomes very rapid, and here the pressure still is required.

Tycos thermometers as well as pressure gauges are dependable throughout the process. In the first treatment where fractionization is employed the thermometers enable precise observation of how great or how little heat is to be used under the stills. Each precaution must be taken in cracking for kerosene. The product obtained as the next heavier grade from naphtha receives chemical treatment and is then removed to be redistilled in the fire and steam stills. While gasoline is obtained from the lighter naphtha, kerosene is obtained from this second heavier product. The oil to produce kerosene is fed from one still to another in a series, each employing a successively high temperature. Heat is applied by fire and continuous sprays of steam, the free steam passing up through the oil carrying off the oil vapors from the top of the still where they are condensed.

In the case of gasoline, steam is alone used for heating, the danger of combustion being too great when fire is applied under the stills containing the highly combustible naphtha. Here also free steam is sprayed to carry off the oils up through a tower where they are cleansed.

Without precise temperature measurement the oil industry as it exists today would not be possible. There would be so much waste in lost derivatives that only a small proportion of the much needed gasoline, kerosene and lubricating oils could be obtained. We would thus lose what little we have, and there would have been such a handicap in the matter of fuel that the automotive industries would surely never have reached their present important place in our affairs. It is a matter now of taking advantage of the utmost economy in fuel production. There are new methods and improvements being discovered, and these are made possible with the aid of the thermometer. They will prolong the day of the gas engine, and perhaps save us from an oil-dry planet.—Tycos-Rochester.

MAKING BOLTS FIT TIGHT

In connection with some work on American battleships, a report of the Bureau of Standards says it was found necessary to use bolts capable of withstanding unusually high shearing stresses. The best type of bolt for such purposes is one having a tight bearing over its entire length. The bureau was requested to devise a method by which such tight-fitting or "body-bound" bolts could be secured. Two methods were tried, both of which gave satisfactory results.

In the first case the bolts were finished a little larger than the holes in the plates. They were then immersed in liquid air until they contracted sufficiently to enter the holes quite easily. Upon warming up, the bolts expanded, gripping the plates tightly. In the second method each bolt was provided with a small hole along its axis and was finished to be an easy fit in the plates.

After insertion a charge of powder was exploded in the small hole. This expanded the bolt, causing it to grip the plates. Subsequent physical tests indicated that the strengths of the joints secured by both methods were sufficiently high for the purpose.

PROVINCE BUILDS CEMENT PLANT

Believes It Can Turn Out the Required Supply at Price Below Market

The Ontario Legislature in committee of supply on the estimates approved of a vote of $1,000,000 for the carrying out of Hon. F. C. Biggs' scheme to establish a provincial cement plant. The Minister explained that the amount voted would build a one-unit plant with a capacity of something over 300,000 barrels annually, which would be sufficient to supply the needs of the province for its provincial highway program. He stated the location of the plant had not been decided upon, but that the department was negotiating for options on alternative sites. It was expected that the province would be able to produce cement at prices much below those prevailing, and moreover would be assured of an adequate supply instead of having its work held up by difficulty in getting delivery.

AN ADAPTABLE WRENCH

The Universal Wrench Co., Detroit, Mich., have opened a factory and office in Windsor, where they will manufacture their universal adjustable wrench. This wrench differs from the usual type of adjustable wrench by the addition of a lever mechanism which permits of pressure being applied to the jaws. A heavy duty spring opens the jaws to the determined position, when the lever is released. Among other advantages claimed is the non-slip feature—as it is said that the wrench cannot slip off the nut. It is also adaptable to smaller space as the handle need not be swung from flat to flat, but only far enough to permit the grooved jaw to grip on the nut angle. These wrenches are made of special material and are turned out in sizes from 4 to 18 inches.

ANNOUNCEMENTS

The Chicago office of the Uehling Instrument Co., of New York, manufacturers of fuel saving equipment, was moved May 1st to the Great Northern Building, 20 West Jackson Boulevard. Mr. Walter C. Lange, who has been appointed manager of this office, is particularly well qualified to co-operate with power plant operators in solving problems of fuel conservation because of his former experience in this field with the Consolidated Gas Co., of New York, and the Hammel Oil Burning Equipment Co., and, until recently, in the New York office of the Uehling Instrument Co. Mr. Lange is a member of the American Society of Mechanical Engineers and a graduate in mechanical engineering of the Stevens Institute of Technology. Uehling Co. recording equipment and other boiler room instruments will be on display in the new office.

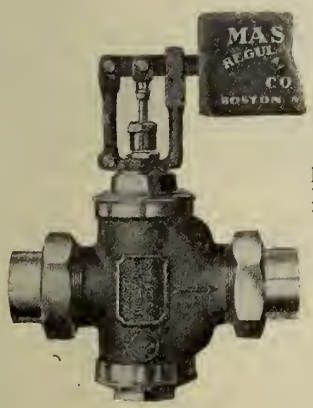
Where You Buy Principles!

DID you ever consider that "principles" are the thing to buy when choosing Valves, Steam Traps or Regulating Appliances. Far greater than mere claims—of more consequence than outward appearance—are the principles that shape a manufacturer's policy.

When you buy Mason Appliances you also get "principles." Principles that allow nothing to interfere with the high standards of Mason efficiency. You buy these principles and yet they cost you nothing.

New Bundy Return Steam Trap

Mason Standard Bronze Reducing Valve



Mason Balanced Valve

MASON EQUIPMENT

is the result of over forty years' manufacturing experience. Service, reliability and positive action is built into Every Mason Appliance.

At your service, in your choice of Mason Devices, is a staff of competent Engineers. Their job is to see you don't waste money on the wrong type of equipment.

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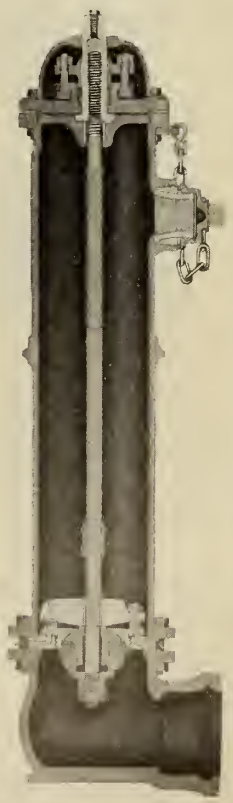
DARLING

VALVES AND HYDRANTS

Licensed Manufacturers in Canada Under Darling Patents

Embodies the greatest improvements in the manufacture of valves made during the past twenty years. Unquestionably the best designed and best built gate valve on the market.

Darling Hydrants will stand harder usage than any other make. When necessary to remove the internal parts, including seats, for examination, it can be done with less expense than any other make. It only requires the services of one man for a few minutes.



DOMINION STEEL PRODUCTS COMPANY, LIMITED

BRANTFORD CANADA

Montreal: 416 St. James Street

DEPARTMENT O

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	29 50
1¾-in.	29 75	27 00
2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
3½-in.	63 50	43 50
4 -in.	85 00	55 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$5 25	$5 25
Plates, ¼-in. up	4 75	4 75

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger, net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.00

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15
Standard	0 15 to 0 40
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15
Carriage bolts, 7/16 and up	Net
Coach and lag screws	20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	5
Machine bolts, ⅜-in. and less	30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 27½
Solder, guaranteed	29½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$32 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	34 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	40 00	42 00
Copper sheet, planished, 16-oz. base	46 00	48 00
Braziers', in sheets, 6 x 4 base	38 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13½
X L C R	14½		

Colored

Lion	13½	Popular	10½
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10½
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

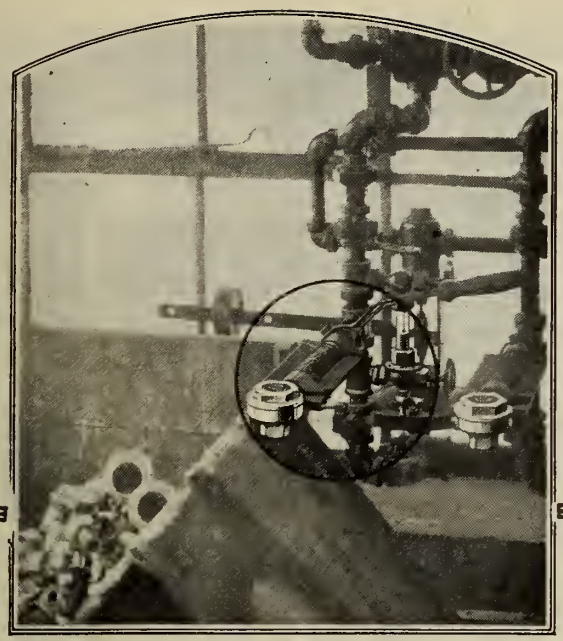
	Mont.	Toronto
Tin	$39 00	$40 00
Spelter	7 75	7 50
Lead	5 75	7 50
Antimony	8 00	8 25
Aluminum	34 50	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs.. sq. ft..	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.



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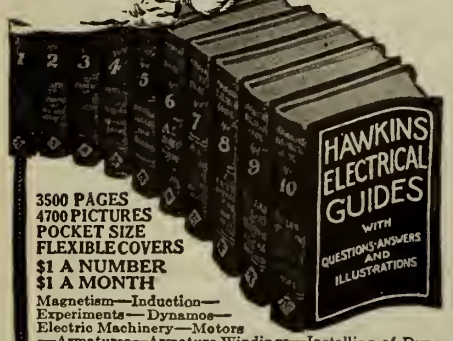

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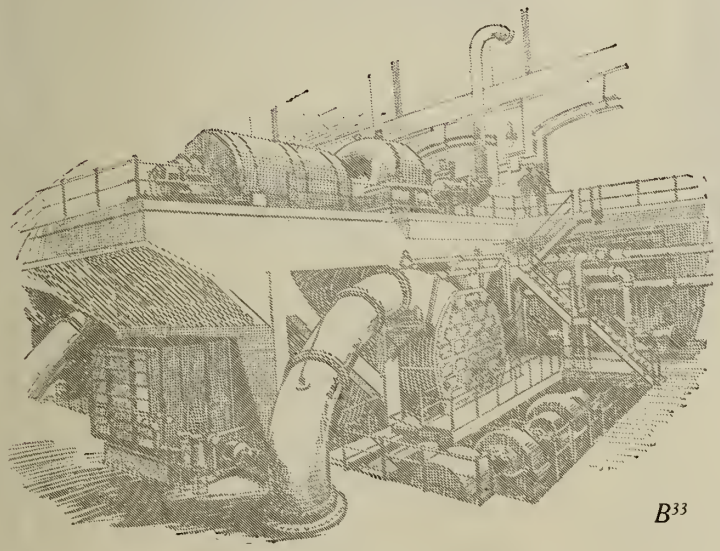

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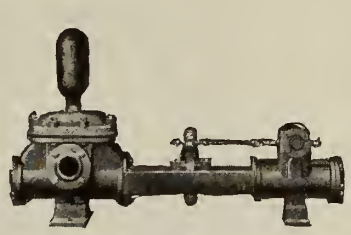

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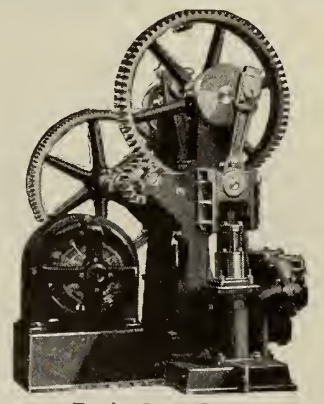
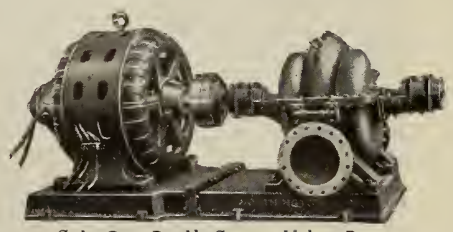


Triplex Power Pump



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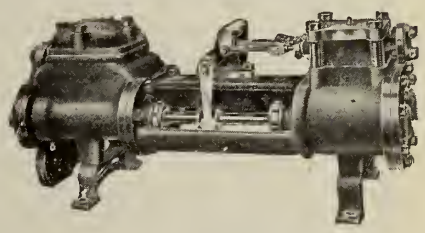

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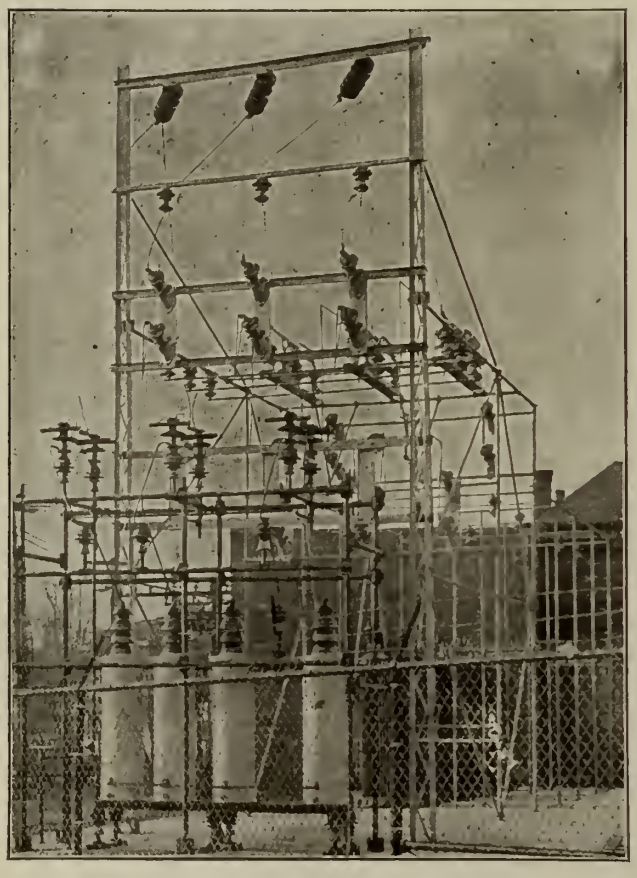

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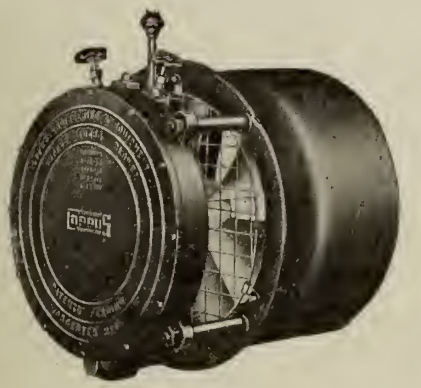
Instead of a new Chimney



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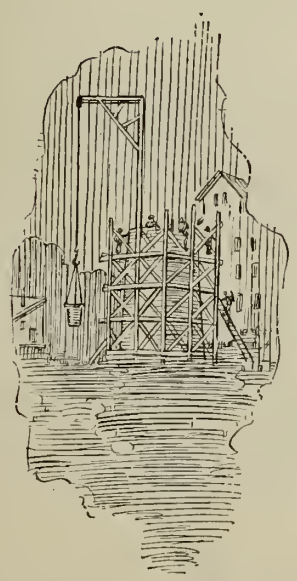
TURBO BLOWER



WHEN the need for greater draft for your boilers arises you naturally think of a new chimney as the logical remedy.

A chimney has serious limitations—it is costly to erect, requires time, and causes many inconveniences around the plant, such as accumulated material, dirt, dust, scaffolding, and no small amount of danger.

Instead of a new chimney, think of the advantage of a Coppus Turbo Blower at only a mere fraction of the cost of a chimney, with far more satisfactory results.

The Coppus Turbo Blower provides abundant draft for any boiler and increases combustion even with the cheapest grades of fuel.

The Coppus overcomes the draft resistance of the fuel bed and the boiler by forcing the air through the fuel bed, leaving to the stack the overcoming of boiler resistance only.

Tests have demonstrated that the Coppus Turbo Blower adds 25 to 100 per cent. to the rated capacity of a boiler, and in connection with mechanical stokers often as much as 200 per cent., saving the installation of new boilers and the necessity of enlarging the plant to accommodate them.

Which is cheaper in the long run, and more satisfactory—a compact, automatic, easily-regulated Coppus Turbo Blower, or an expensive, cumbersome stack, lacking in the results that make for economy in the power plant?

The answer is Coppus, with its Valve Control of Your Steam, economy and better combustion. Therefore, instead of the new chimney, install a Coppus Turbo Blower and get greater economy.

Shall we send you the booklet fully describing their construction, installation and advantages? We shall be glad to do so on your request.

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"The Spectre"

By Guy Morton

"LONGREEN was not a quibbler.

"'I am sorry, Grimley' — he came straight to the point—'but we are compelled to dispense with your services at the end of the month. Turner's for the past six months has been having a terrible pull. We got overstocked on the rising market and now, with the market falling every day and getting more and more into the customers' hands, we have to retrench or crash. We have chosen to retrench. Every stick of decorative employment is being cut out of the store. . . .'"

What Spectre? The Spectre of Unemployment—a spectre which all too many have encountered during the past few months. If you have not personally encountered this spectre, so graphically described in its causes and consequences by Guy Morton, you may count yourself amongst the fortunate, but there will be no doubt as to your interest in his story. If you have encountered it, nothing can stop you, once you start this story, from reading it to its unusual and constructive conclusion.

It is a great piece of fiction, told by the same author who wrote "Personality Plus" in the March 15th MacLean's.

Review of Reviews

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Sir Philip Gibbs

Can Germany Pay?...Stephane Lauzanne

Lighter Side of Diplomacy
Maurice Francis Egan

The African Lung Fish
Scientific American Monthly

Shock Cures Shock.....A Psycho-Analyst

Ten and a Half Dollar Novels
George Moore

Soil Subsidence in England....Daily Mail

Ten Others

"The Drama of Our Great Forests": Life and Love Return— *By Arthur Heming*

This is the seventh installment in Mr. Heming's wonderful account of life in our northern forests and pictures the fascination of real romance in the wilds.

"Have Faith in Our Nationals"— *By Agnes C. Laut*

There is no use always knocking, says Miss Laut. By a constructive policy of immigration and settlement, some of these deficits can be vastly reduced.

"Conversation vs. Closure"— *By J. K. Munro*

Premier Meighen is struggling against great odds to carry through some constructive legislation. According to Mr. Munro, they are really not getting anything done at Ottawa—and he tells how they do it in his masterly, pungent, pithy, witty fashion.

"She Wasn't a 'Type' So She Became a Directress"— *By Edith M. Cuppage*

The story of a B.C. woman who wanted to get into the movies—and got there, despite everything, in the administrative side.

"Heads Million Dollar Corporation"— *By Dorothy G. Bell*

The story of a Canadian girl who went to the States with an idea that she might become a dancer, but has made for herself a niche as head of a million dollar financial corporation.

"Our Own Mediterranean"— *By Elton Johnson*

What's what at the present time in regard to the movement which is on foot to make ocean ports of our Great Lake ports.

"Making Good on Four Ambitions"— *By Sinclair Laird*

The story of W. S. Bullock, a member of the Provincial Legislature of Quebec Province, who did not know his multiplication table at 19 and is now a leading educationalist.

"Pawned"— *By Frank L. Packard*

This masterly story of a triple regeneration is drawing swiftly to its conclusion: John Bruce and Crang meet again at death-grips.

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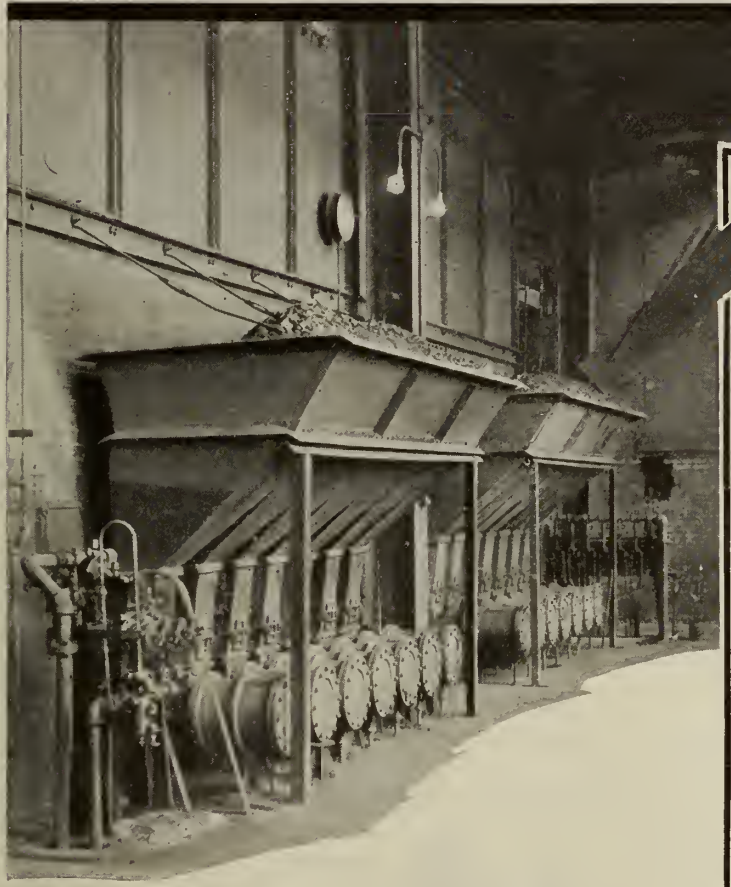

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In the "A-C" (Automatic-cleaning) type, fires are automatically cleaned.

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Clinkers do not form on bridge or side walls.

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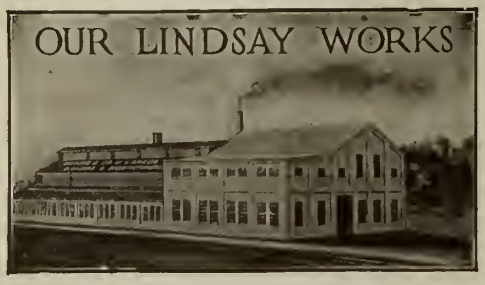

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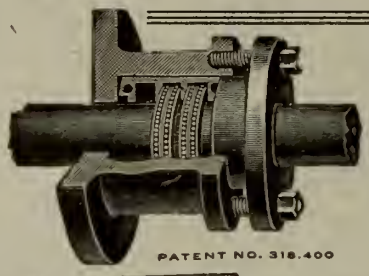

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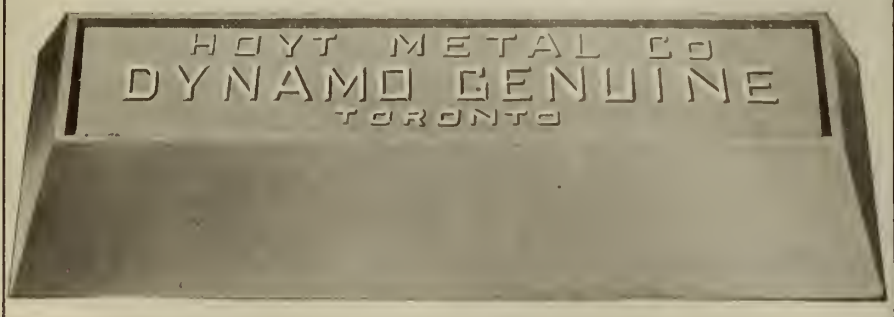

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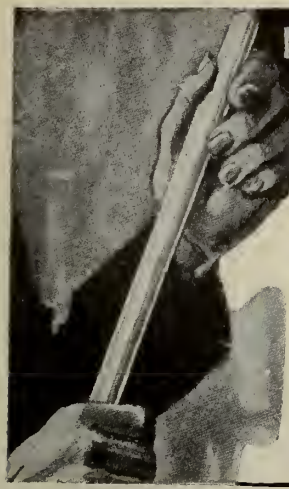

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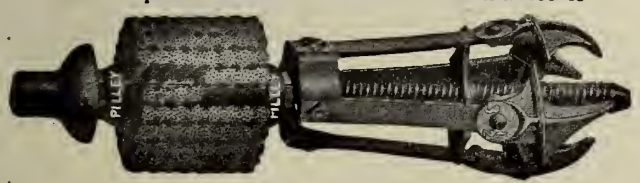

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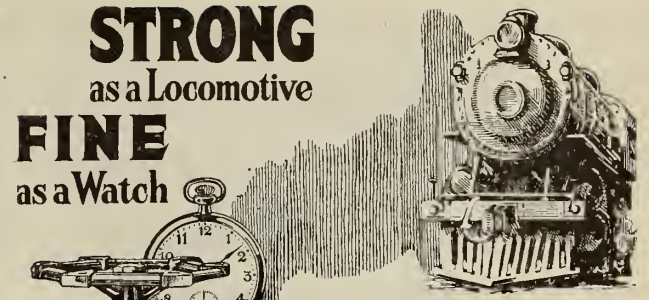
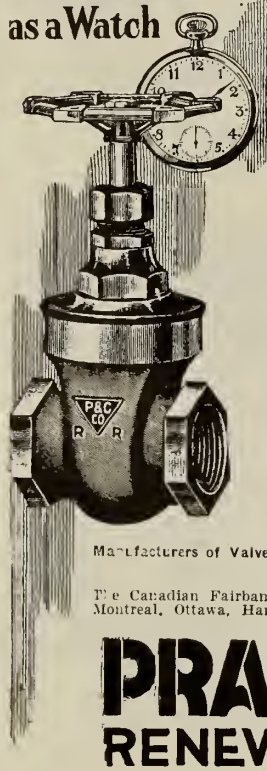
STRONG as a Locomotive FINE as a Watch





For sheer physical strength, plus delicate adjustment, no valve can compare with a Pratt & Cady.
Old-time users of Pratt & Cady Valves who have found valves in their plants as good as the day they were installed, thirty or forty years before, marvel at their durability.
But when you consider their massive construction, the superior grades of metal used, the painstaking labor expended on their construction, and the renewable disc (or renewable seat) feature which practically makes a new valve out of a Pratt & Cady Valve that has seen long service, there is every reason why they should last indefinitely.
Write for our Valve Catalog showing Globe and Gate Valves for every type of service.

PRATT & CADY CO., INC.
Manufacturers of Valves and Asbestos Packed Cocks that give long and satisfactory service.
Factory, Hartford, Conn.
The Canadian Fairbanks-Morse Co., Ltd., Halifax, St. John, Quebec, Montreal, Ottawa, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

PRATT & CADY RENEWABLE VALVES

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Power Plant Equipment

Equipment purchased from us, whether new or used, can always be depended upon to give the utmost value for the money it cost.

During the past half century we have built up a reputation for "quality and service" which is well worth considering when purchasing power plant equipment.

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A Free Co-operative Service for Engineers and Employers. A register of qualified men which manufacturers may consult and to which we may refer when our advice is requested.

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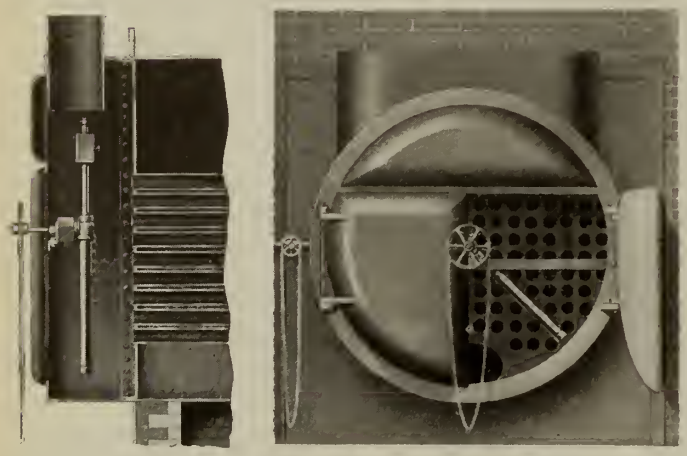
TORONTO

The appalling waste of coal in the operation of Return Tubular Boilers



Some years ago the Engineering Department of the University of Illinois conducted a test of Vulcan Soot Cleaners in Return Tubular Boilers.

For 5 days they allowed soot to accumulate; then 5 when tubes were cleaned daily; then 5 more of no cleaning. The result of that test was conclusive evidence that most Return Tubular boilers, not equipped with soot cleaners, waste an appalling quantity of coal.

The test showed an increase in evaporation due to clean surfaces of 13%. It indicated a DECREASE in coal burned per square foot of grate per hour, due to clean surfaces, of 32.16%. It showed a lowering of stack temperature, due to clean surfaces, of 17.59%.

It is plain that maximum evaporation and minimum coal consumption don't go together when the tube surfaces are heavily coated with soot—a perfect insulator, the most efficient dissipator of heat known! It is obvious that the soot must not merely be removed OCCASIONALLY, as is done with the hand lance, but REGULARLY, at stated intervals, as is done by the Vulcan Cleaner. Without this regular cleaning, soot has time to build up, retard evaporation and increase coal bills.

The owner of Return Tubular boilers that are not equipped with Vulcan Soot Cleaners may take it for granted, therefore, that he is paying for this equipment many times over yearly in lowered efficiency and unnecessary coal wastage.

Ask for a copy of our folder "SPENDING $796 TO SAVE $1,017.40." It is a revelation to the plant owner and engineer of the tremendous possibilities of Vulcan Soot Cleaners as dividend-paying producers.

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS, PA. OFFICES IN THIRTY CITIES

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HOMESTEAD Quarter-Turn Valves

Stay Tight!

Because the seating surfaces are always exposed and subject to cutting and scoring, it is practically impossible to keep globe or gate valves tight for any length of time when the service is severe.

Homestead Quarter-Turn Valves are **seatless.** They stay tight!

Only one-quarter turn of a convenient handle is required to open or close Homestead Valves. Adopt them and you'll save time, trouble and expense.

Homestead Valve Mfg. Company
Homestead, Pa.

Notice how the mechanic handles a Williams' Drop-Forged Wrench. There is confidence in his very grip—he knows the trade mark, W has stood for superior quality for nearly half a century.

Forty different patterns in 1,000 sizes with openings from 3/16 to 7 5/8 inches; a *standard* wrench for all power house service.

Ask your dealer, or write for Wrench Book illustrating Drop-Forged Wrenches, Screw Wrenches, Stillson Wrenches, etc., etc.

DROP-FORGINGS
often cheaper than castings
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Thermometers Now Repaired in Canada

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We would be pleased to receive visits and inquiries from those interested either in new equipment or repairs.

Taylor Instrument Companies

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There's a Tycos and Taylor Temperature Instrument for Every Purpose.

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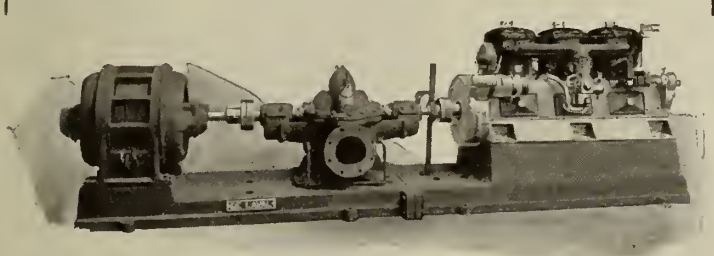
Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

When such eminent engineering firms as Hill & Ferguson, of New York City; Alvord & Burdick, of Chicago; Chipman & Power, of Toronto, and many others of prominence specify emergency equipment like this:



One of 2 Six Cylinder 120 H.P. Sterling engines installed at Champaign-Urbana Water Company, Champaign, Ill., by DeLaval Steam Turbine Company, of Chicago, for reserve. Engine arranged for speed of 1160 R.P.M.

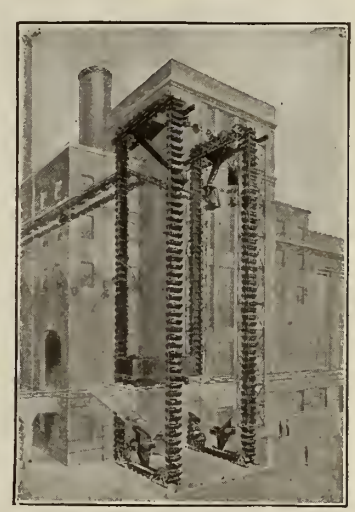
Sterling Engine Company

Dept. C. 4

Buffalo, New York

"MEAD-MORRISON"
CANADIAN MM C CANADIAN MM C

McCaslin Conveyors



For carrying coal, ashes, cement, ore, sugar and other substances.

Built in sizes with buckets from 15″ x 15″ with capacity of 25 tons of coal per hour to 34″ x 36″ with capacity of 160 tons of coal per hour.

STEAM HOISTS—cut gearing and bronze-bushed drums.

GRAB BUCKETS
of all kinds

AGENTS:
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Made in Canada By

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
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114 Liberty Street - - - New York, N. Y.

TRANSFORMERS

For Immediate Shipment From Canadian Points

2—25 K.W., single phase, 60 cycle, Packard Electric Company Transformers, 6600/550 volts, outdoor type. Oil cooled. Condition O.K.

2—40 KVA, single phase, 60 cycle, Allis-Chalmers Transformers, 2200/550 volts.

3—75 KVA, single phase, 60 cycle, General Electric Transformers, 13200/2300 volts, indoor type. With oil. In first-class condition.

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3—500 KVA, single phase, 60 cycle, Moloney Electric Company Transformers, 6600 volts primary, 550 volts secondary. Oil cooled, indoor type.

MACGOVERN & COMPANY, Inc.

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BRANCH OFFICES:
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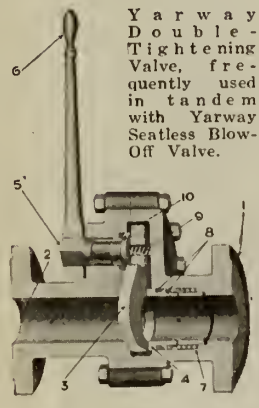
You couldn't do it then but now's your chance



Yarway Double-Tightening Valve, frequently used in tandem with Yarway Seatless Blow-Off Valve.

When the cry was for more production and still more production, 24 hours a day, day in and day out, you only had time for temporary repairs — and not even those could be made like you wanted to make them.

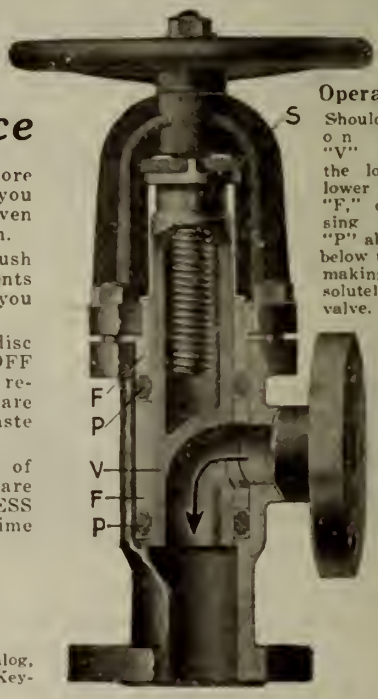
But now's your chance. During the lull after the rush is the time to make these changes and improvements that you have wanted to make and that will prepare you for the next rush period.

Now is the time to replace the old style seat and disc valves with a new YARWAY SEATLESS BLOW-OFF VALVE. With such a valve, the delays caused by reversing, renewing or regrinding seat and disc valves are eliminated altogether, which are a nuisance and a waste even when production is not forced.

Not only are the seat scoring and cutting difficulties of seat and disc valves done away with, but there are other features which make the YARWAY SEATLESS BLOW-OFF VALVES more serviceable. Now is the time to investigate them.

YARNALL-WARING CO.
7604-20 Queen St., Chestnut Hill, PHILADELPHIA

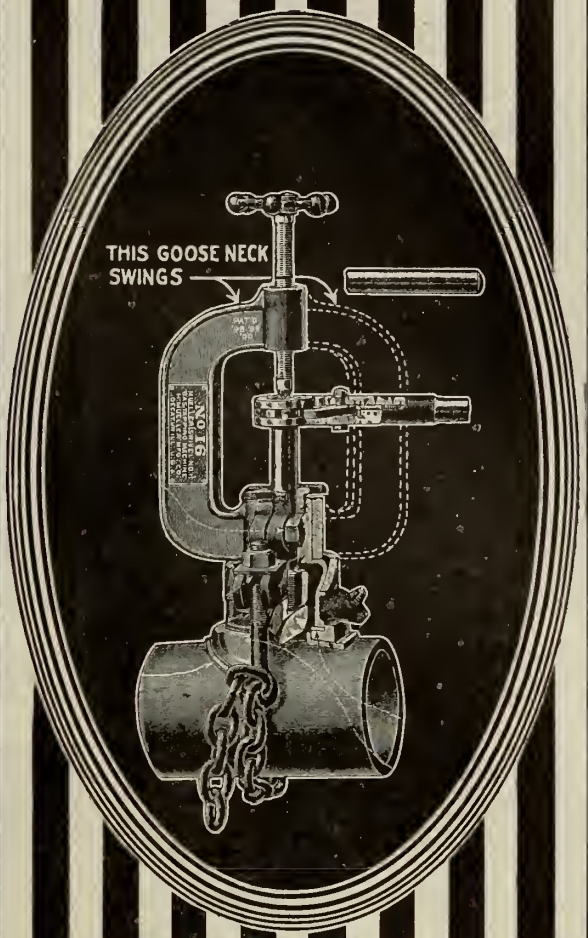
For complete list of offices, see Sweets' Engineering Catalog, Condensed Catalogs of A.S.M.E., Sterling Marine Catalog, Keystone Mining Catalog or Chemical Catalog.



Operation
Shoulder "S" on plunger "V" engages the loose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

YARWAY

SEATLESS BLOW-OFF VALVES



Mueller Tapping Machine No. L.

Makes taps from 3/8 to 2 inches in all sizes of pipes under pressure. The Goose Neck is swiveled, turning to any position to allow ease in operating the Ratchet Handle. The special Mueller Oiling Device supplies oil to the tool through the Gas Cylinder.

Mueller Gas Tapping Machines are made in eight different patterns for tapping open gas mains, or mains under pressure. Over 90% of Tapping Machines in use are Mueller built—proof of their efficiency and superiority.

Write today for detailed descriptions and prices.

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Water, Plumbing and Gas Brass Goods and Tools

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Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.

Shipment of Four 150 H.P. (72 in x 18 ft.) Return Tubular Boilers for 150 lbs. working pressure. January, 1921

Established 1834.

Head Office and Works, London, Canada

Toronto Reps.—ARTHUR S. LEITCH CO., Limited, 1001-2 Kent Bldg., TORONTO

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Can a Barrel be Emptied through the *Bunghole* as *Quickly* as it can be Filled through the Open *Head?*

Seems like a foolish question. Yet this is the principle on which most steam traps are designed—with an opening of only ¼" in the discharge valve while the pipe connection has a 1½" hole. And then you wonder why you require such a large, expensive trap to handle your condensation.

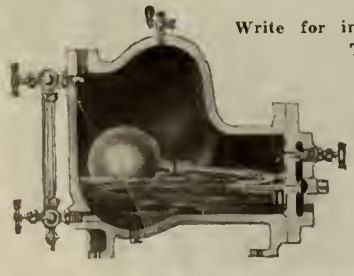
It's different with the American Ideal. Here the valve discharge orifice is much larger than in ordinary traps.

AMERICAN IDEAL STEAM TRAP

has a larger discharge capacity at the different pressures than any other trap having the same size inlet. Consequently you can use a smaller trap of the American Ideal **continuous flow** type than of other makes.

It is the only trap with a powerful enough leverage to operate a valve with such a large orifice.

Because of this powerful leverage, we can use a heavy float, of **thicker, stronger** seamless copper which will withstand a pressure of 600 lbs. to the square inch. This heavier float eliminates the danger of the float collapsing and enables us to guarantee it for the life of the trap.



Write for interesting booklet "A Steam Trap Catechism."

American Steam Gauge & Valve Mfg. Company
Boston, Mass.

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SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

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GUARANTEED TO LAST THREE YEARS

Without Renewal.
Drop us a line and let us tell you all about this remarkable packing and our "Safety" Superheat Sheet Packing.

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In Cotton Tubes

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McLAREN'S
Genuine British Oak Tanned
Leather Belting
Every Inch
Is Really Dependable
Just as the drip! drip! drip! of water will wear away a stone, so will the slip! slip! slip! of a pulley wear out a belt—and waste considerable power doing it.
Because it will not slip, is tough and durable and just as stretchless as a leather belt should be,
D. K. McLaren's Leather Belting is the cheapest belting you can buy.
Many of Canada's better equipped power and industrial plants are users of D. K. McLaren's Belting.
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RUSSO SHEET, suitable for all joints. Indestructible. Asbestos Fibre made waterproof. JOINTS DO NOT HAVE TO BE FOLLOWED UP. In sheets 50 x 100 inches—1-32, 1-16, 3-32 and ⅛ inch thick.

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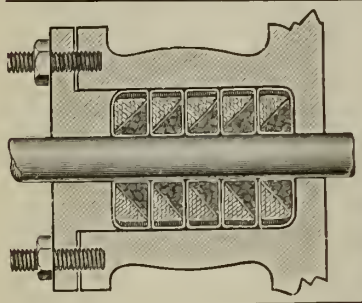
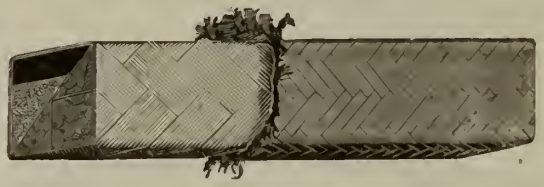
For all Steam Pressures up to 250 lbs. Its sectional construction allows for wear. Elasticity is given by the Rubber Cushion. Stability by the Metallic Strips in the Asbestos Section.



COMBINATION

Sectional for
Steam and Hydraulic



This packing is giving the greatest satisfaction on the largest pumps in Canada. Excellent for either hot or cold water. The flax section rides on the rod or plunger.

ALSO THE CELEBRATED **JOHN CRANE** FLEXIBLE METALLIC
For All Purposes

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KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Jenkins Valves

Made *for* Maximum Service

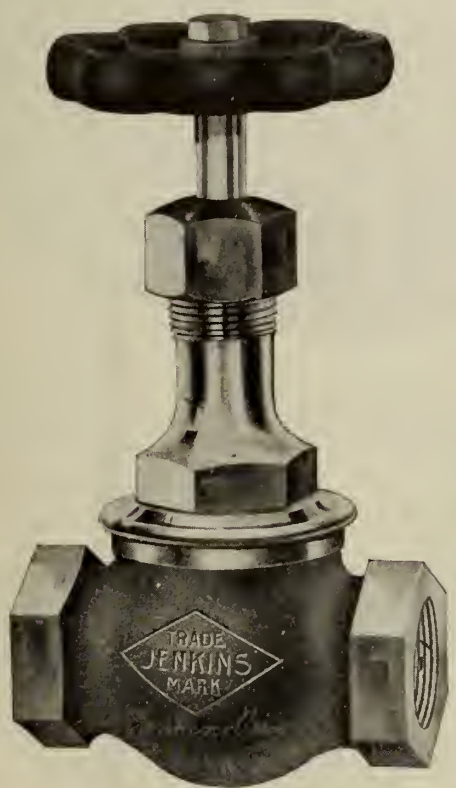

Fig. 106
JENKINS BRASS GLOBE VALVE
Suitable for 175 lbs. Working Steam Pressure or 250 lbs. Working Water Pressure.

The dependability and longevity of genuine Jenkins Valves are due to the fact that every valve in every type is made for the Maximum Service.

The man who knows valves and valve requirements installs Jenkins. Their trouble-free record in every branch of Service is a guarantee of satisfaction even under unusually severe conditions.

Jenkins Valves for every service are obtainable at supply houses everywhere. The line is very complete, including valves of brass, iron and cast steel for all requirements of power plants, industrial establishments, plumbing and heating service, etc. When buying look for the name "Jenkins" within a Diamond Mark on the body of the valve. It's there for your protection.

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ESTABLISHED 1885

Gives Long Life to Machinery

Good Lubricating Oil, carelessly stored and inefficiently handled, causes more expensive and less efficient lubrication than does ordinary oil, properly stored, and handled according to modern systems of economy.

A Bowser Stream Feed Circulating and Filtration System will solve your problem and give long life to your machinery. Bowser will also cut your fuel costs. Extensive surveys show average savings in fuel costs of five per cent. where stream feed lubrication is in use as compared with hand lubrication methods.

There is a Bowser Circulating and Filtration System for *your* purpose.

Write for illustrated literature

S. F. Bowser Company Limited

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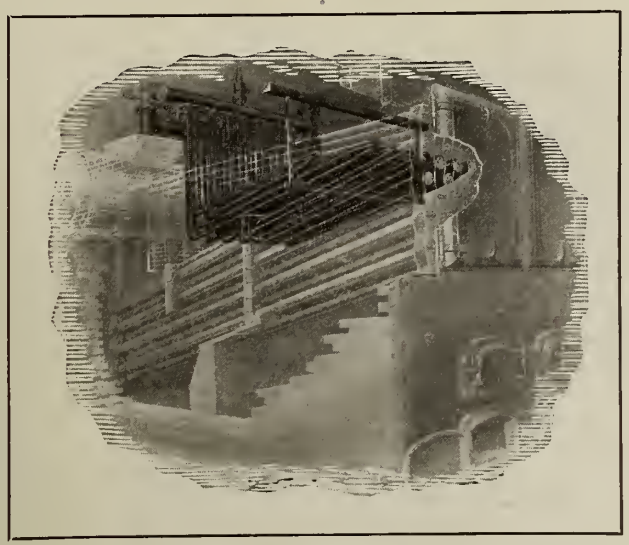

Don't Scrap Your Plant Equipment—

Modernize It!

Two courses, in general, are open to effect higher economy and greater capacity in power plant operation. The first method—the scrapping of equipment considered uneconomical or inadequate and replacing it with new, economical apparatus—is seldom justifiable to-day, not only because of high labor and material costs but because recent development of modernizing methods makes available methods whereby improved operation may be obtained at a moderate cost.

The second course—the programme of modernization involves making the best possible use of equipment now in operation by simple and inexpensive conversion—conversion whereby economies and capacities closely approximating those of the most modern plants may be realized at a fraction of the cost involved by a scrapping and rebuilding programme.

Because for their first cost, ELESCO Superheaters render higher net returns than any method known or practiced to obtain economy, ELESCO Superheaters should have first consideration in your modernization programme.

The advantages of superheating are disclosed in Bulletin NT-5, sent at your request.

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TRANSPORTATION BUILDING, MONTREAL

WORKS AT SHERBROOKE, QUE.

British Columbia Representatives: The Taylor Engineering Co., Ltd., Vancouver, B.C.

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all purposes.

ELESCO

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MADE IN CANADA

USE THIS COUPON.

The Superheater Company, Ltd.,
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Please Send your Bulletin NT-5.

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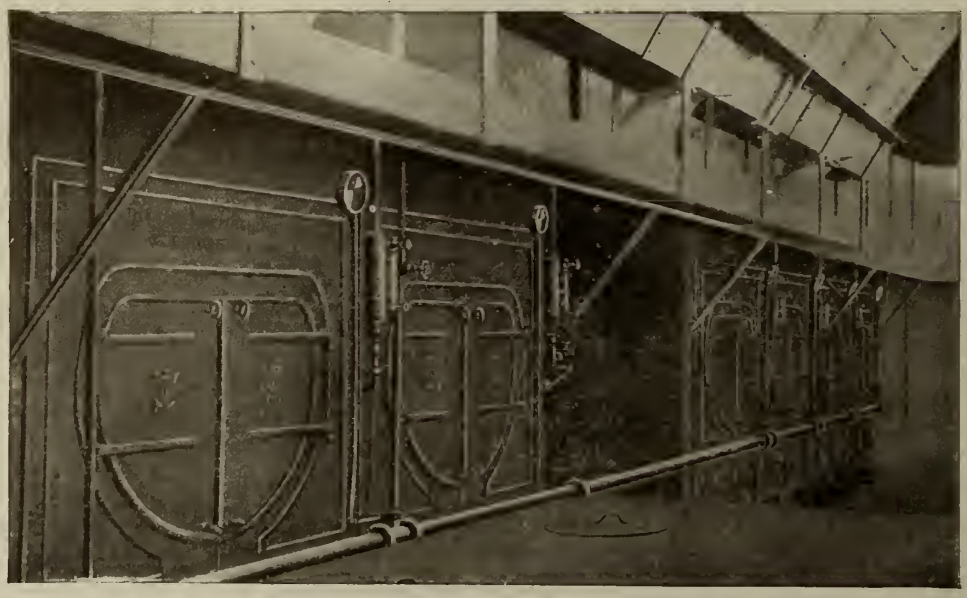

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We have a mighty convincing answer to that question. Any size—any type. And to inquiries for plate work, tanks, grey iron and brass castings.
Now is the time to set your house in order.

Engineering & Machine Works of Canada, Limited

St. Catharines, Ontario

Eastern Sales Offices: **Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal**

George Geiger, Chief Engineer, McGraw Plant, Kelsey Wheel Co., Detroit, Mich., is enthusiastic over the long service he obtains from

TRADE MARK
"PALMETTO"
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TWIST PACKING

for he realizes, as does every other thoughtful engineer, that long service under hard conditions can only be obtained from a packing that is made of the first grade of heat-resisting materials.

The cheap, so-called asbestos twist packings are cheap because made of low grade short fibre asbestos, held together with a heavy percentage of cotton.

A packing to give the economy of long service must have quality, and even our competitors acknowledge "Palmetto" is first quality.

CONVENIENT—Any size valve packed from one spool of "Palmetto" Twist. It can be unstranded, each strand a perfect packing.

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Sole Manufacturers, 109 Duane St., New York.

Let us send you a free working sample.

Canadian Agents: The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver

By properly metering steam flow, Republic Flow Meters give you Fuel Efficiency, Boiler Efficiency and Plant Efficiency. By conserving steam the Republic saves fuel.

Republic Flow Meters

The Republic gives you a complete "accounting record" of your entire plant on a conveniently located instrument board. This is made possible by its exclusive feature — Electrical operation.

Republic Flow Meters Co., of Canada, Ltd.

145 Wellington Street West
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See Page 18

Bulletin on Request

Eastern Representatives:
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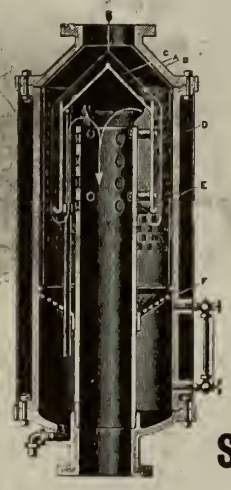
185 Dagenais Street, MONTREAL

Agents for Manitoba and Saskatchewan
W. W. HICKS & CO. - Winnipeg

Agents for British Columbia
TAYLOR ENGINEERING CO., LTD., Vancouver

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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DIRECT SEPARATOR COMPANY
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General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator

has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

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NONPAREIL *SHAKING AND DUMPING* GRATES

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Why continue spending $1 for results which can be secured for 90 cents? The odd dime is just thrown away! Nonpareil Grates will enable you to pocket it. Why not give us a call to-day?

Brickyard Equipment

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New Time Punch Revolutionizes Recording Thermometers

NOW you can keep a day and night tab on the man responsible for maintaining the correct temperature in your heat-treat process or elsewhere, as well as on the hour to hour and minute to minute variations in the temperature.

The Columbia Recording Thermometer is now equipped with a brand new feature—a TIME PUNCH attachment which makes it a two-in-one instrument that does double duty. It not only records every fluctuation in the temperature, but also shows whether the man in charge has been watching these fluctuations as he should.

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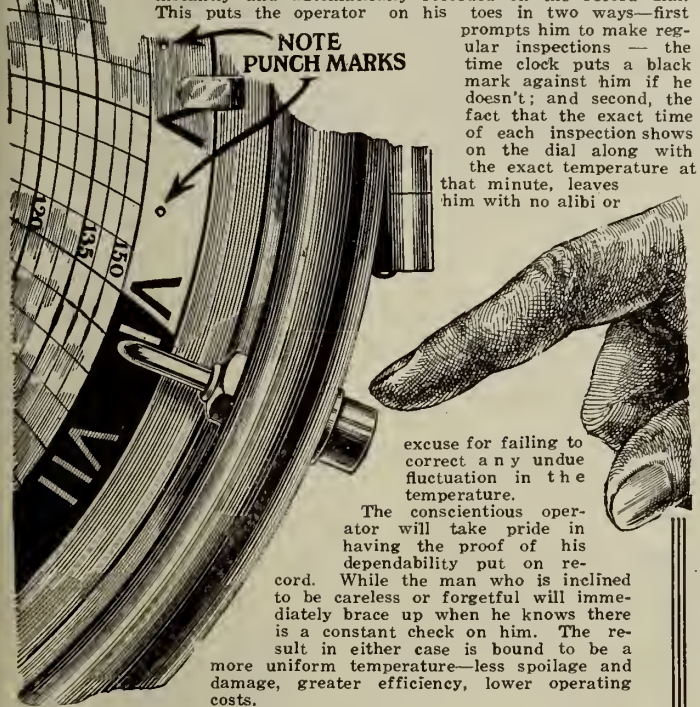

The conscientious operator will take pride in having the proof of his dependability put on record. While the man who is inclined to be careless or forgetful will immediately brace up when he knows there is a constant check on him. The result in either case is bound to be a more uniform temperature—less spoilage and damage, greater efficiency, lower operating costs.

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The product of the paper mills is measured in tons, and exact records are kept of the tonnage produced daily, weekly, monthly, and yearly. As the amount of coal delivered to the mill for the production of steam is always known to the ton, it is an extremely easy matter to work out the consumption of coal per ton of paper produced.

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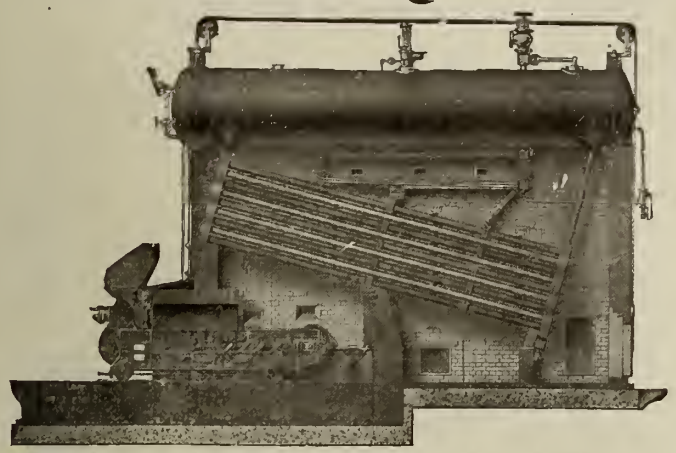

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Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

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Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
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Can. Link-Belt Co., Toronto, Ont.

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H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y

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Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Dominion Steel Products Co., Ltd., Brantford, Ont.
Holden Co., Limited, The, Montreal.

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Holden Co., Limited, The, Montreal.

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Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

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Leonard & Sons, Ltd., E., London, Ont.

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Mason Regulator & Eng. Co., Ltd., The, Montreal.
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Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
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Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
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EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y

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Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester Mass.
Sturtevant Co., B. F., Toronto, Can.

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Babcock & Wilcox, Ltd., Montreal
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Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont
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Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Mackinnon Steel Co., Ltd., Sherbrooke
E. J. Phillip & Sons, Toronto.
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Scaife & Sons, Wm. B., Pittburgh, Pa
York Mfg. Co., York, Pa.

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W. R. Sexton Co., Toronto.

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Gates Refractories, Ltd., Montreal.
Beteon Plastic Fire Brick Co., Rome, N.Y
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FIRE BRICK MORTAR
Beveridge Paper Co., Ltd., Montreal.
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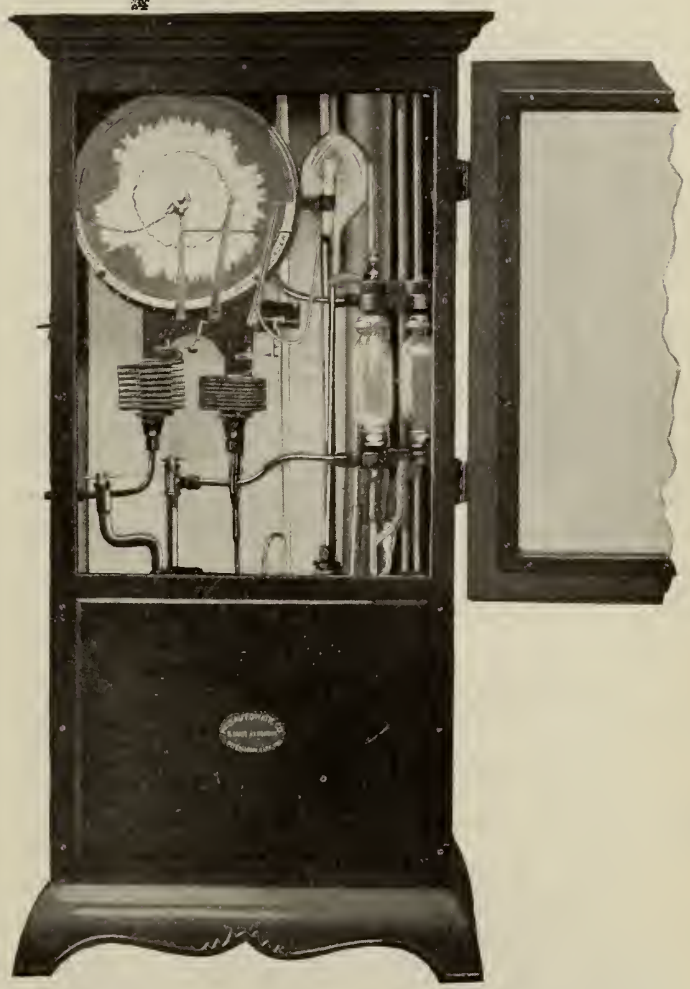

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Holden Co., Limited, The, Montreal.
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Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
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Penberthy Injector Co., Windsor, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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Babcock & Wilcox, Ltd., Montreal.
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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
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Can. Link-Belt Co., Toronto, Ont.
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Arthur S. Leitch Co., Ltd., Toronto.

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Can. Fairbanks-Morse Co., Ltd., Montreal
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Sturtevant Co., Ltd., B. F., Galt, Ont.

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R. G. Long & Co., Toronto, Ont.

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Waterous Engine Works Co., Brantford.

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Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

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J. H. Williams & Co., Brooklyn, N.Y.

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Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
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Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

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HOISTS, CHAIN
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MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

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Gutta Percha & Rubber Co., Limited

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited

HOSE, STEAM, SUCTION AND WATER
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Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

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Can. Fairbanks-Morse Co., Ltd., Montreal
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Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

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INSULATORS
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S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

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Can. H. W. Johns-Manville Co., Toronto.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

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W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

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Jeffrey Mfg. Co., Montreal, Canada.

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Green's Economiser, Ltd., Toronto.

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Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

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LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg Co., Brooklyn, N.Y

2 things to find out about your Steam Traps

1. Do they discharge air and water?

WAIT, now, before you say "yes" to this question. Are you certain that, to prevent air binding, your men aren't letting a little live steam blow through the traps each time they discharge so the air will be carried out with it—or the pet cocks may be left partially open to prevent air binding.

Wasting steam this way may be better than having air-bound traps, but it is expensive.

The simplest, most reliable and cheapest way of keeping steam lines free of air and water is by the use of the Johns-Manville Steam Trap. It discharges the air *with the water*, continuously, and without the familiar but expensive last puff of live steam of ordinary traps.

2. Do they retain steam?

Maybe you say "Yes, if the packing is O. K.," or "If it doesn't stick," or "When the thermostatic member is adjusted properly."

But why even think about packing or mechanisms or adjustments? An efficient trap can be so simple that these considerations are needless.

The Johns-Manville Steam Trap, with no valves, levers or thermostats, just a hollow, floating copper ball, prevents loss of steam. It discharges air and water *as they are received*, without regard to temperature or any other condition except the mere fact that the air and water are in the trap and should be got rid of without losing any steam.

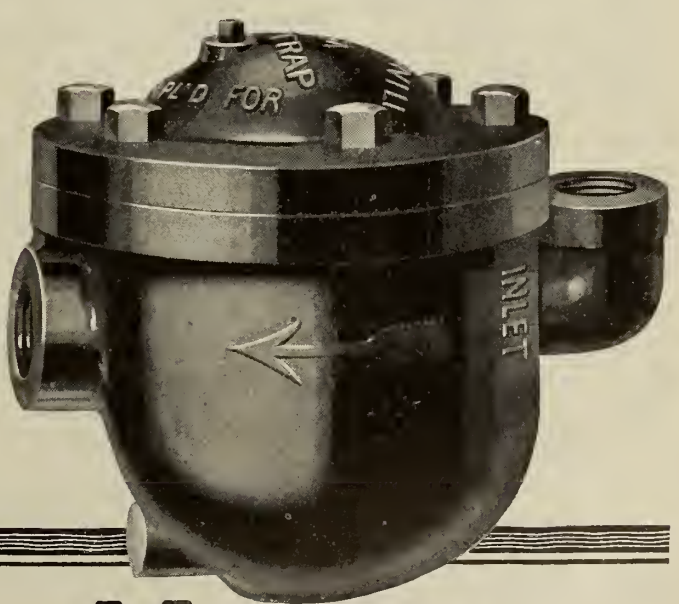
An unattached floating ball is the only moving part of the trap. Part of its surface acts as the valve, its radius as the lever arm and its weight as the counterweight. The forces that control its movement are the buoyant force of the liquid and the unbalanced pressure on the area of the discharge orifice.

When the entering water raises the ball, the discharge orifice is exposed and the water and air are free to flow out of the trap.

When the water level drops, the ball drops, gradually rolling over the discharge orifice, thus throttling down the outflow and maintaining sufficient water in the trap to provide a water seal and prevent the leakage of steam.

Why not have a Johns-Manville engineer consult with you regarding Steam Traps, and tell you about the Johns-Manville Steam Trap and how it will benefit you?

CANADIAN JOHNS-MANVILLE CO. LIMITED
Toronto Montreal Winnipeg Vancouver
Hamilton Ottawa Windsor



JOHNS MANVILLE SERVICE
COVERS THE CONTINENT
Through—
Asbestos
and its allied products
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Serves in Conservation
Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE
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METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd.. Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

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S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

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Beldam Asbestos (Canada) Co., Toronto.
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Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
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Beveridge Paper Co., Ltd., Montreal.
W. J. Brown (Tucks), Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

PACKING, ENGINE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Beldam Asbestos (Canada) Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Beldam Asbestos (Canada) Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Beldam Asbestos (Canada) Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Beldam Asbestos (Canada) Co., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
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MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
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Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
[illegible] Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
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MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

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Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
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Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

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American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

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Darling Brothers, Ltd., Montreal, Que.
Jeffrey Mannfacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Coppus Eng. & Equipt. Co., Worcester
Pratt & Cady, Hartford, Conn.

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American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
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PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

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Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont
Can. Detroit Lubricator Co., Walkerville
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
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Smart-Turner Machine Co., Hamilton.

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Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Yarnall-Waring Co., Philadelphia, Pa.

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Darling Bros Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

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Uehling Instrument Co., New York, N.Y.

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Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
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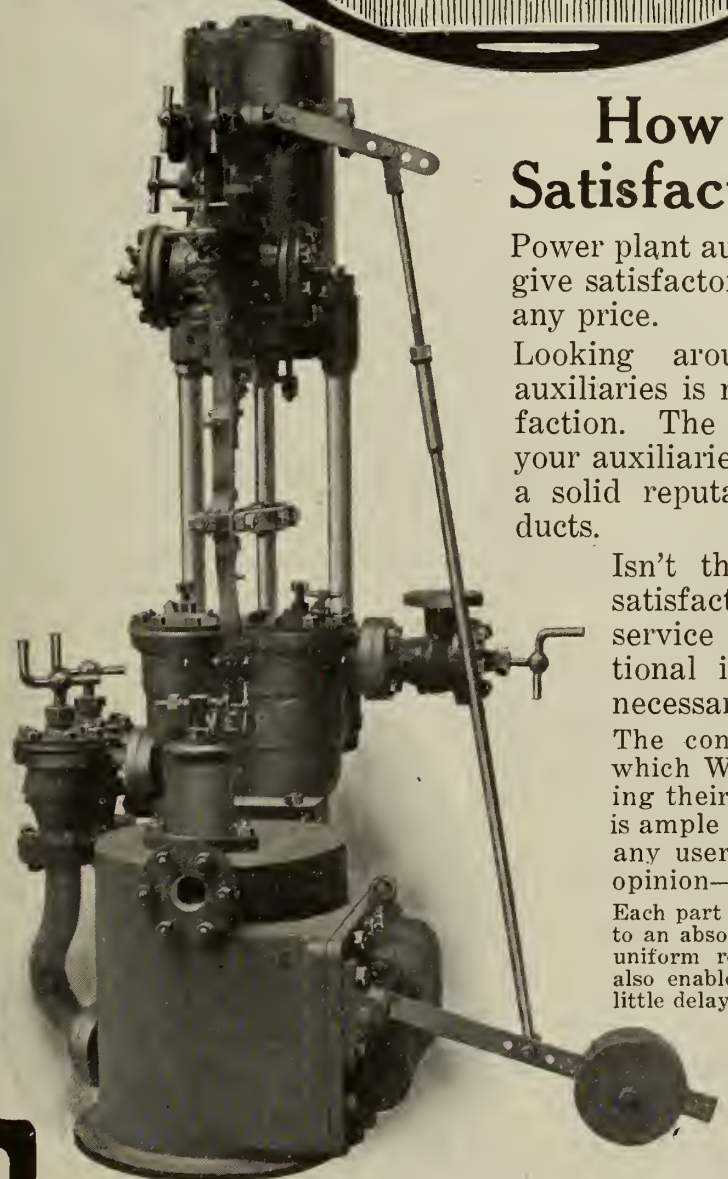
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

WEIR AUXILIARIES



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Sales Engineers

PEACOCK BROTHERS, LIMITED, MONTREAL

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Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Hays Corp., Michigan City, Ind.

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Ice Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
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Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
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REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
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Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

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H. Mueller Mfg. Co., Ltd., Sarnia.

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Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Paper Co., Ltd., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAFES
R. C. Miller Oil & Supply Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

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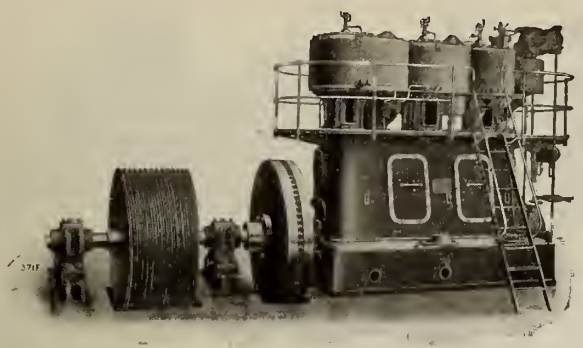

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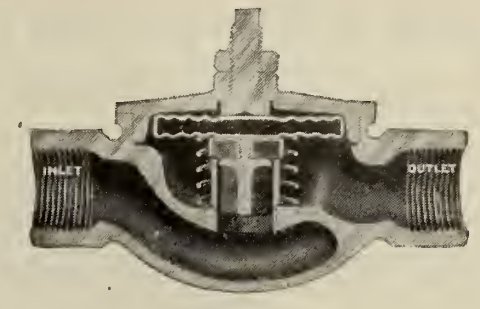

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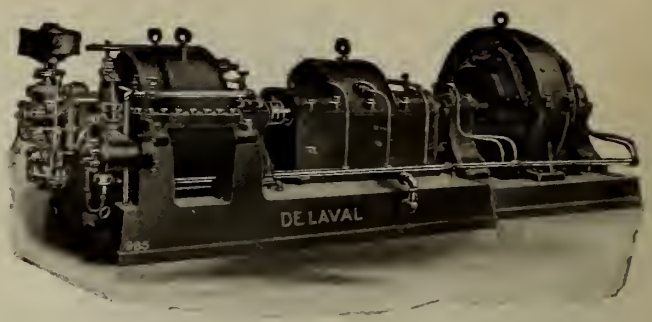

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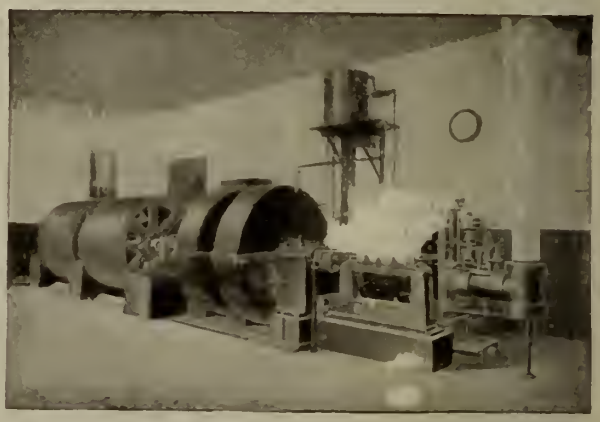

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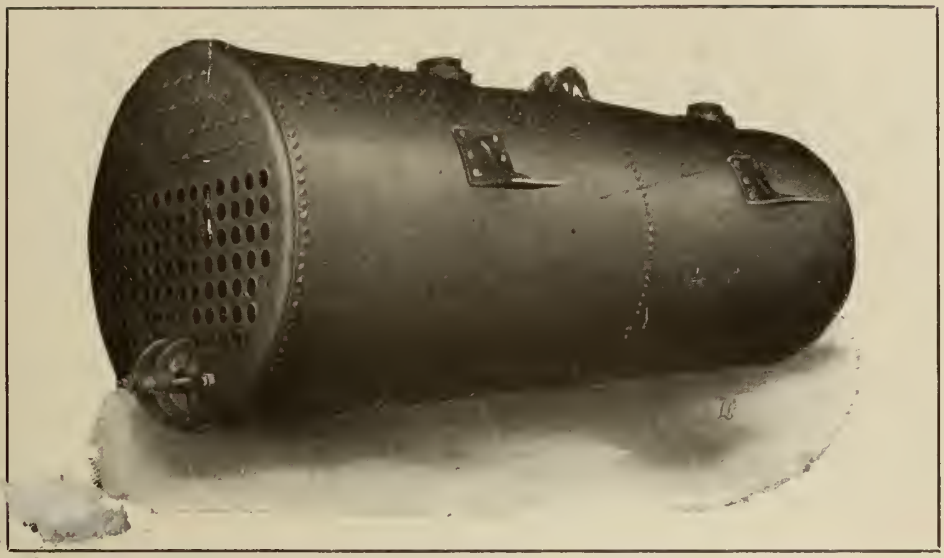

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MONTREAL: Southam Building — LONDON, ENG.: 88 Fleet Street, E.C. — WINNIPEG: 1103 Union Trust Building

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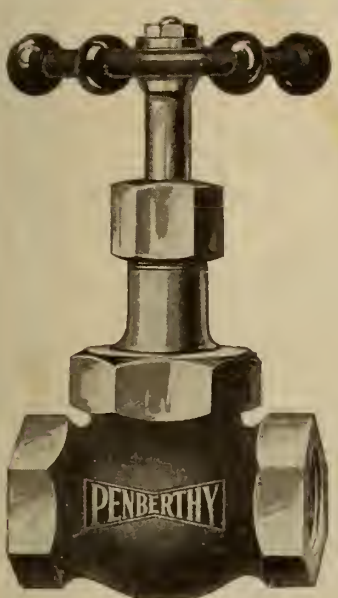
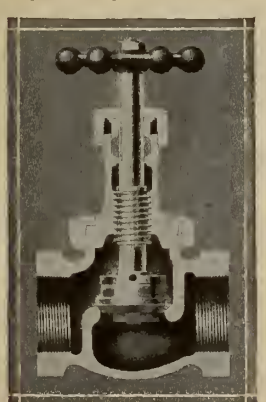


Exterior View
Regrinding Globe Valve



Sectional View
Regrinding Globe Valve

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"With Outside Bonnet Construction"
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Registered and Approved for 200 lbs. Steam Pressure in Ontario and Western Provinces.

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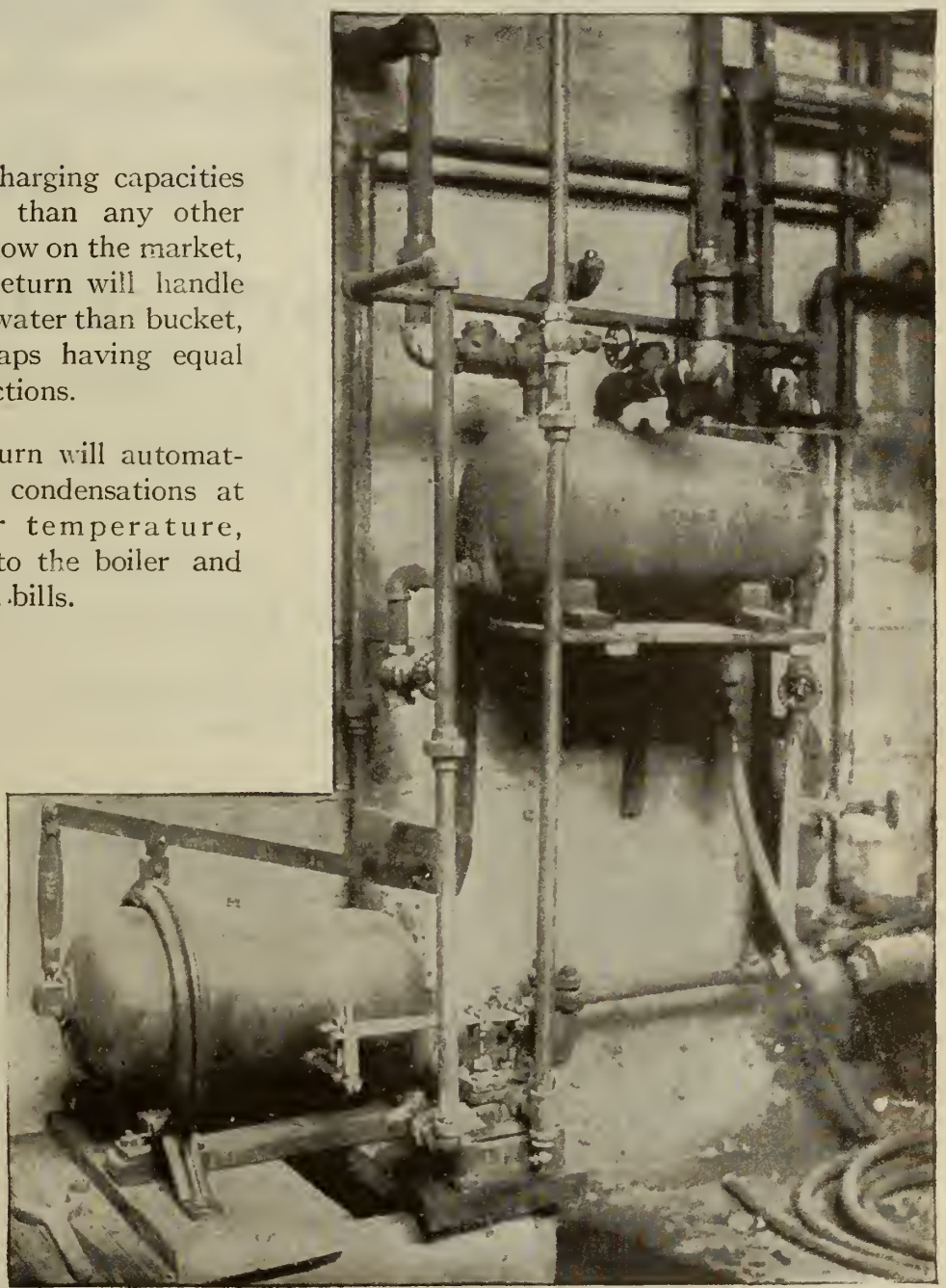
The Direct Return will automatically return all condensations at any pressure or temperature, directly back into the boiler and reduce your coal bills.



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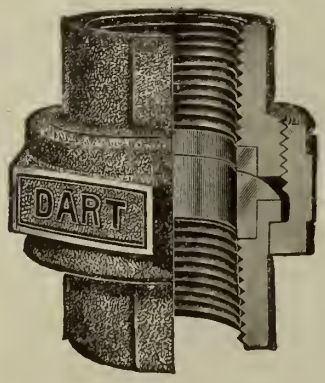

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You never see a Dart Union pipe coupling on the scrap heap. They are used over and over again. No fitting in a pipe line can outlast a "Dart." No depreciation because no deterioration.

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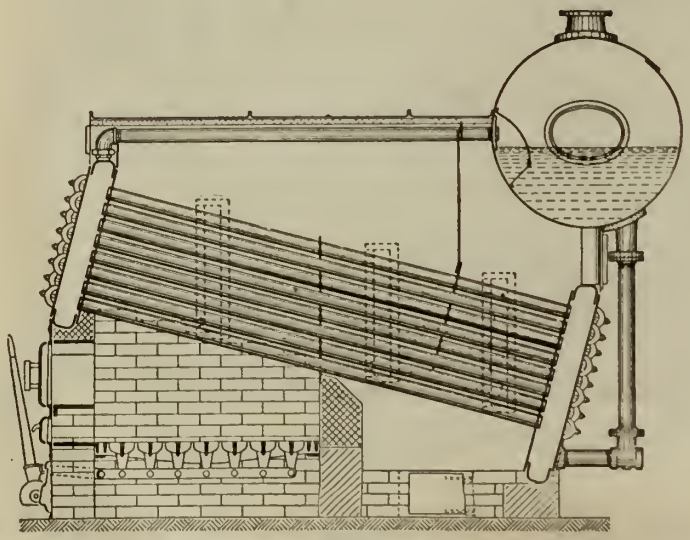

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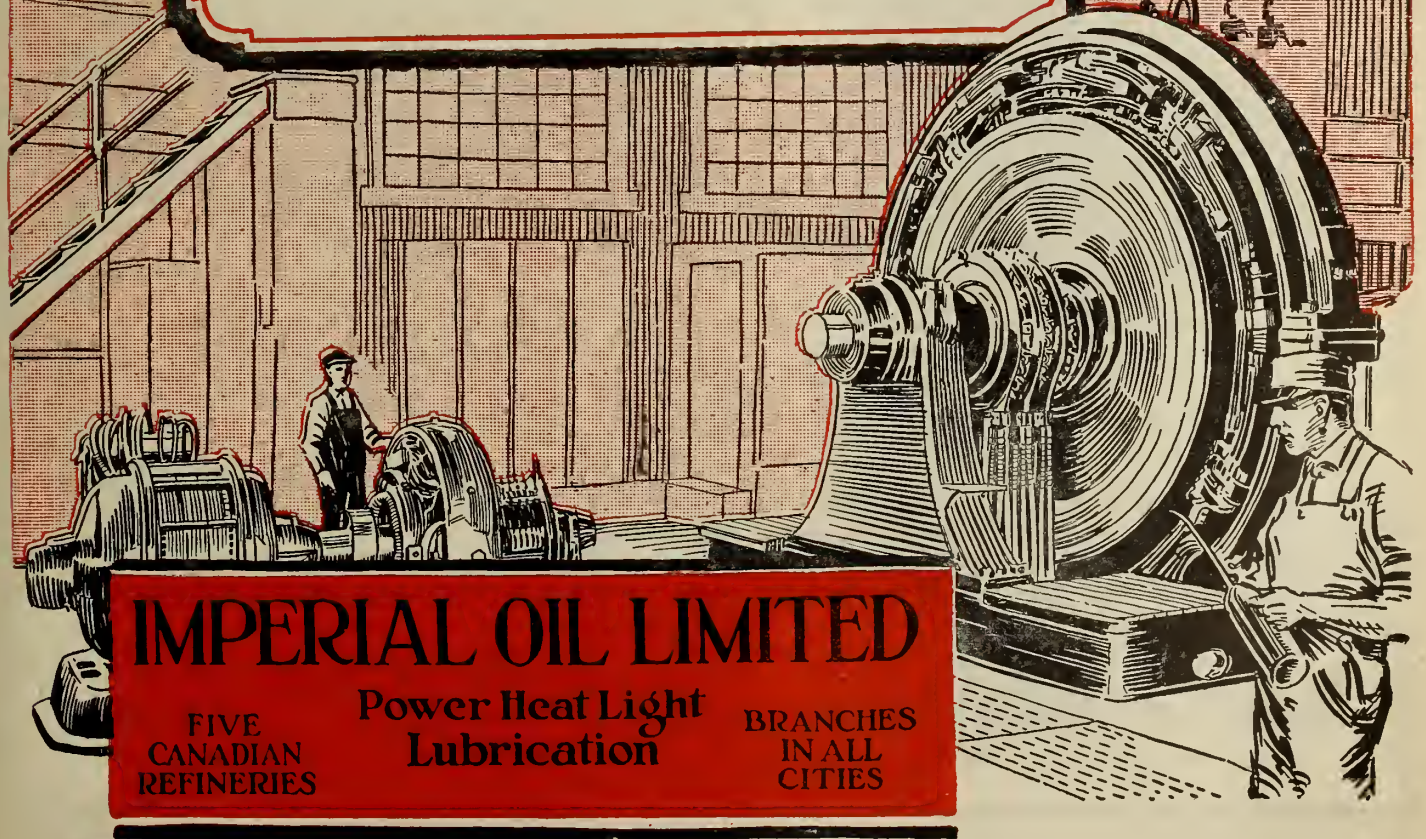

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The demand for our products has steadily increased because the standard of quality has been maintained.

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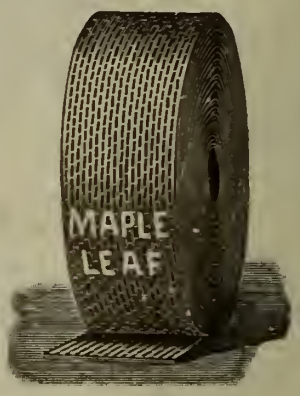

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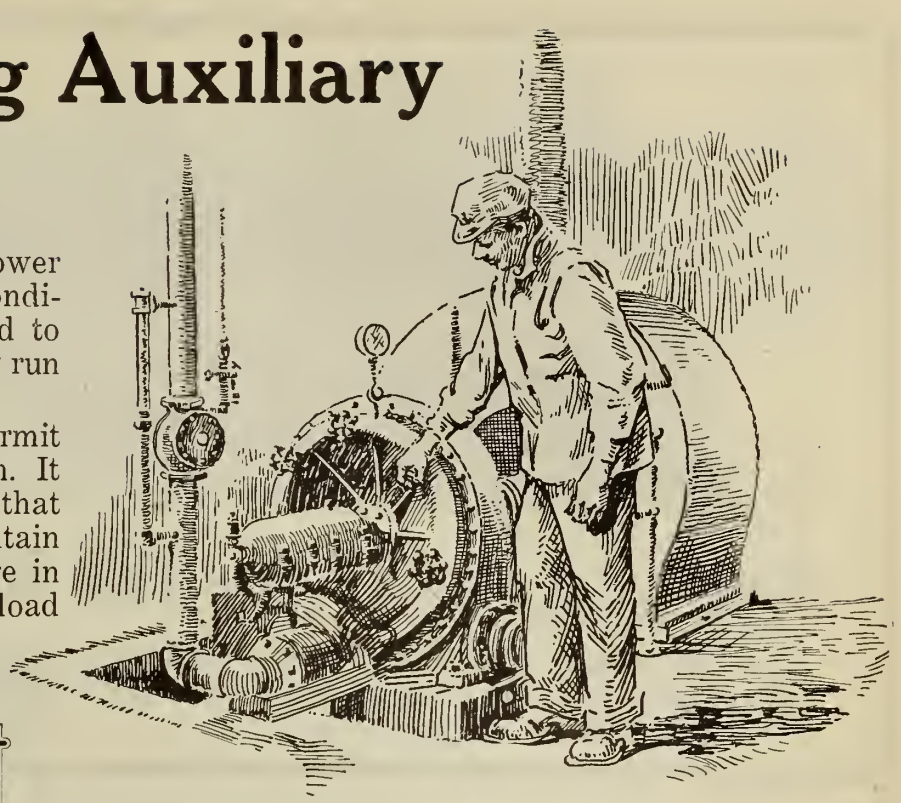

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(TRADE MARK)

Steam Turbines

They are not controlled by throttling down the steam, but by shutting off one or more of the several steam nozzles by the hand wheels on the turbine casing. The nozzles remaining in service undergo no change in efficiency.

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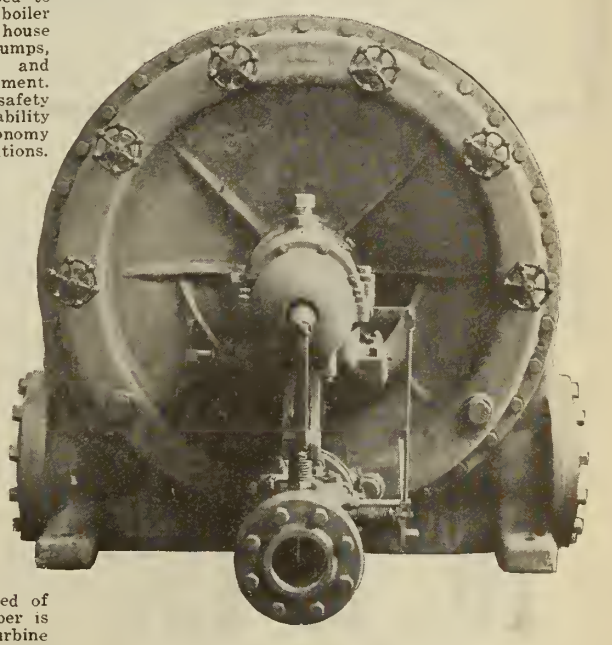
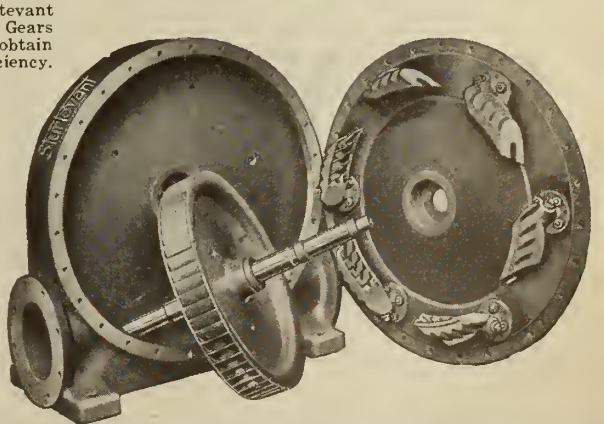
Consultation with our engineers is recommended before selecting any turbine drive.

Write for Bulletin.

Sturtevant Steam Turbines are used to drive exciters, boiler feed pumps, house pumps, fire pumps, fans, blowers and special equipment. They combine safety and dependability with high economy under all conditions.



When the speed of the driven member is below the turbine speed Sturtevant Transmission Gears are used to obtain maximum efficiency.



B. F. Sturtevant Company of Canada, Ltd.

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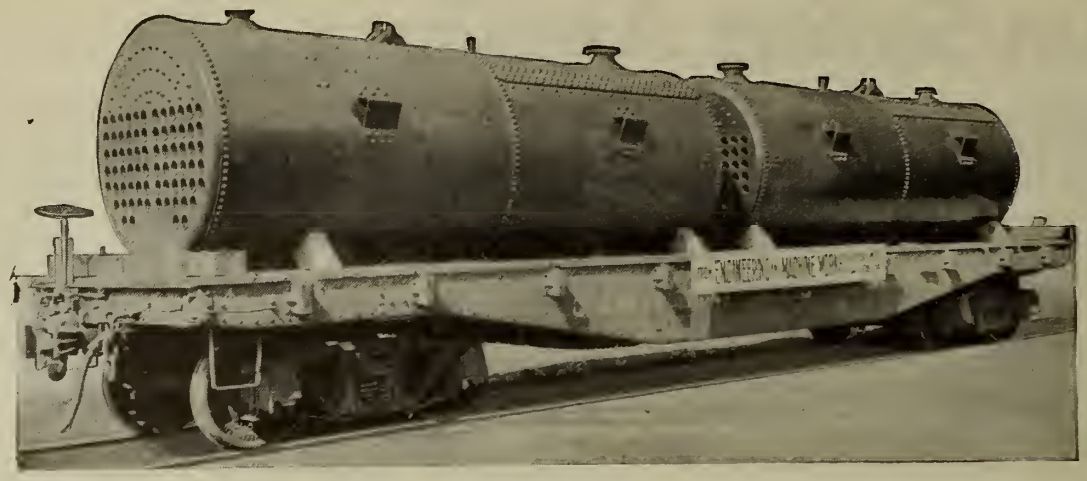

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RADIAL FLOW FANS

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Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED.
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Made *for* Maximum Service

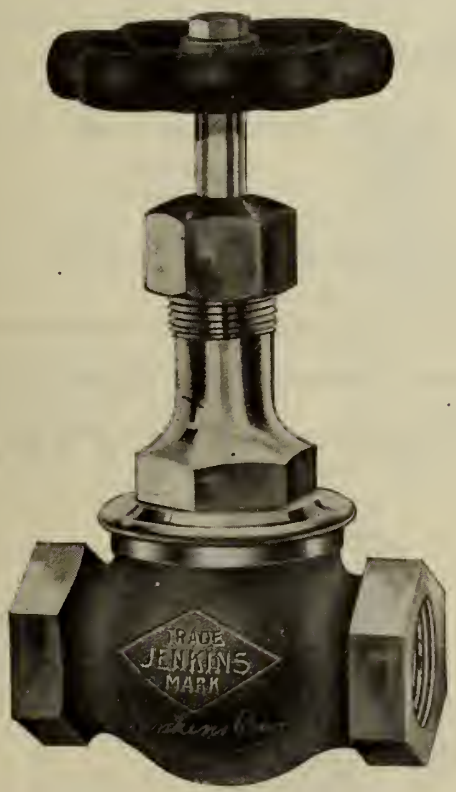

Fig. 106
JENKINS BRASS GLOBE VALVE
Suitable for 175 lbs. Working Steam Pressure or 250 lbs. Working Water Pressure.

The dependability and longevity of genuine Jenkins Valves are due to the fact that every valve in every type is made for the Maximum Service.

The man who knows valves and valve requirements installs Jenkins. Their trouble-free record in every branch of Service is a guarantee of satisfaction even under unusually severe conditions.

Jenkins Valves for every service are obtainable at supply houses everywhere. The line is very complete, including valves of brass, iron and cast steel for all requirements of power plants, industrial establishments, plumbing and heating service, etc. When buying look for the name "Jenkins" within a Diamond Mark on the body of the valve. It's there for your protection.

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The close, personal touch afforded by this organization in all our dealings with our customers, and the prompt service we are thereby enabled to render, has contributed in no small degree to the Confidence which the Trade places in York QUALITY Products.

Whether you are thinking of installing a new plant, require engineering advice, or need supplies for your Ice Making or Refrigerating Plant, it will pay you to write our nearest Branch.

MECHANICAL QUALITY YORK SERVICE **REFRIGERATION**

The Trade in the Dominion benefits by the ability and experience of this Organization through four regularly established Service Stations.

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(Ice Making and Refrigerating Machinery exclusively)

P&H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

P&H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

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NOW is the time, while steam demand is temporarily slack, to reline your furnaces with

PLIBRICO JOINTLESS

FURNACE LINING

By spending a little for PLIBRICO **now** you will save many times the cost in reduced coal bills next winter through having an air-tight, gas-tight furnace lining.

Prepare for firing up by installing PLIBRICO in all your furnaces. Any man about the plant can install it.

No shutdowns for repairs when front-door arches, baffles, side walls and bridge walls are constructed of PLIBRICO.

PLIBRICO comes in steel containers of distinctive appearance as shown below. Warehouse stocks ready in Toronto, Montreal, Vancouver, Winnipeg and Calgary.

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HOMESTEAD
Quarter-Turn Valves

Eliminate Waste Time and Leakage

HOMESTEAD Valves close with a quarter-turn and remain tight without dripping or leaking. A single quarter-turn of the lever opens them to a straight, unobstructed flow.

Made in straightway, threeway and fourway patterns for air, steam, water, oil, gas or acids. Catalog upon request.

Homestead Valve Mfg. Company
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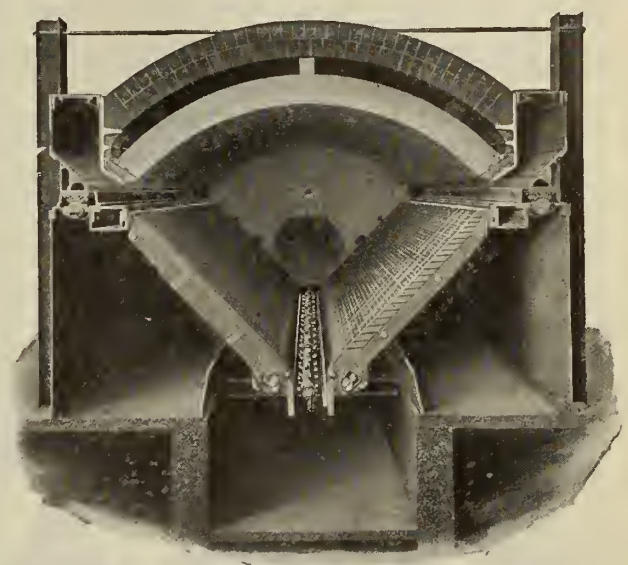
Reducing the Cost of Steam Making



Back in 1907 the New York Air Brake Co. became interested in the possibilities of savings to be made by using

MURPHY AUTOMATIC FURNACES

in place of hand-firing methods. A test made on a 150 h.p. boiler, hand-fired, showed a cost of 20.39 cents per 100 lbs. water evaporated. A Murphy was then put in under this same boiler, reducing the cost to 14.49 cents per 100 lbs. of water evaporated.

This **demonstrated saving,** together with smokeless operation and low maintenance, has led to **three repeat orders** received from this company.

At that time coal cost $2.95 a ton at their plant—to-day that won't cover the freight per ton to most plants.

Think how much more the Murphy can save at to-day's coal prices!

Find out what a Murphy can do for you in your plant. Send for Catalog HM-5.

For information on RILEY UNDERFEED STOKERS for large boilers, see advertisement in last issue or send for RILEY STOKER Catalogue HR-5.

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DETROIT MICH. U. S. A.

High Stack Temperature

Minimum Steam Production

Fuel Waste

Excessive Labor Cost

40% Average Soot Removal by Hand Blowing

It's Your Money --- Take Your Choice

This is the story of Vulcan Soot Cleaners—in a nutshell.

If your plant isn't Vulcan-equipped, you're up against the drawbacks listed at the left.

When your boilers are Vulcan-equipped, you're assured of the advantages listed at the right.

Whatever may be the generally good operating conditions of your boilers, it is impossible to maintain maximum results by hand blowing.

It is only through the installation of mechanical soot cleaners—Vulcans—that steam production can be maintained and fuel saved at the same time.

The lack of Vulcan Soot Cleaners in your boilers spells W-A-S-T-E!

Can you afford it?

Let us tell you all about Vulcans and what they can accomplish for you.

Please mention type of boiler, steam pressure, and number of tubes high and wide.

Ask particularly for folder "Spending $796 to Earn $1017.40"

Low Stack Temperature

Maximum Steam Production

Fuel Saving

Reduced Labor Cost

95% Average Soot Removal by Vulcan Soot Cleaners

The VULCAN SOOT CLEANER COMPANY

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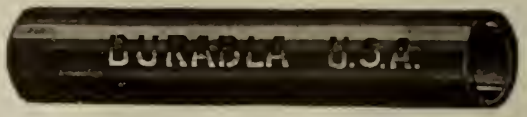
DURABLA

STRENGTH—GOODNESS—QUALITY

Etched on 

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TESTS OF HIGH PRESSURE GAUGE GLASS

Temperature—Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.

Erosion—No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

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Service—Under continuous operating conditions with pressure of 225 pounds, performance equalled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

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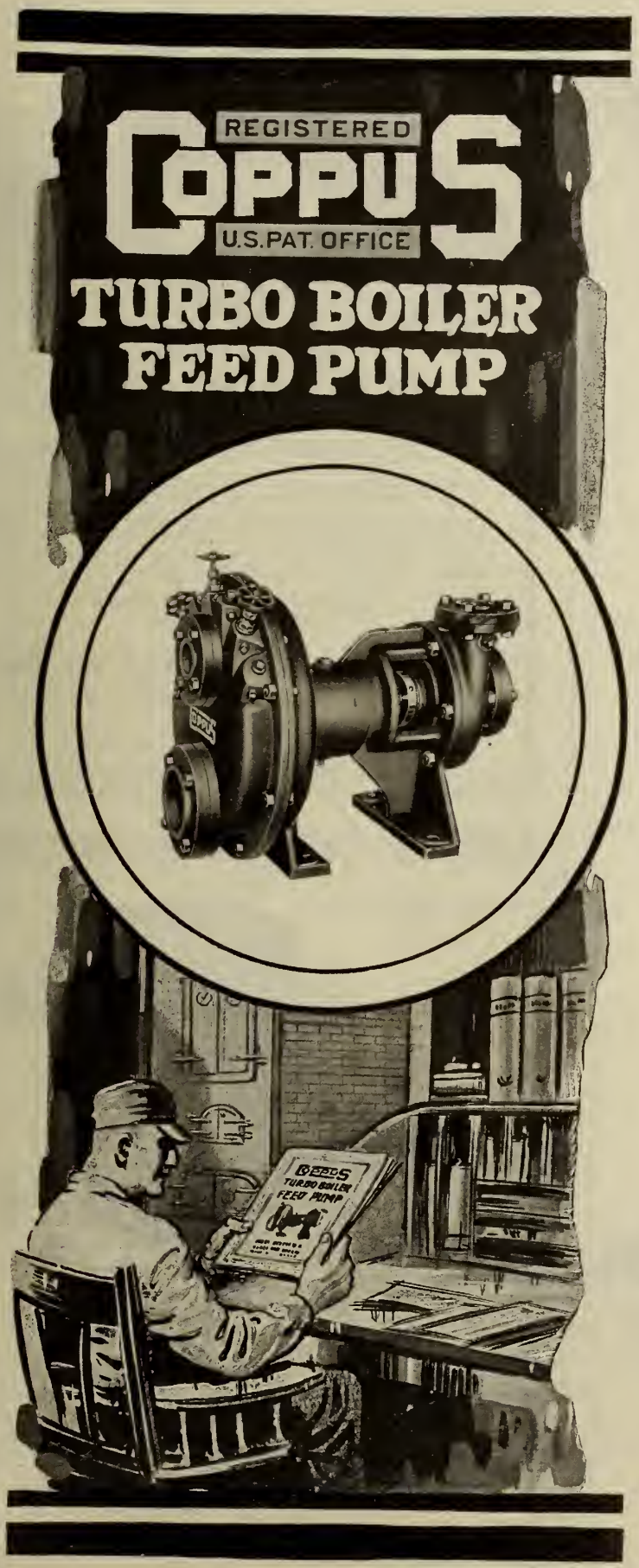

Have You a Feed Water Problem?

If it concerns a pump, here is the answer.

The COPPUS Centrifugal Turbo Boiler Feed Pump specially constructed for boiler feed work, simple, compact and with a single rotating element.

It occupies a fraction of the floor space of other pumps, reciprocating, turbine, or motor driven, and runs continuously without vibration or pulsation in the feed line, which in itself is a decided advantage.

A keen judge of pumps will recognize its superiority for boiler feed work. It is built as a single unit with the turbine wheel and pump impeller on the same shaft—with only one stuffing box that does not require repacking.

Every COPPUS Pump is equipped with an excess pressure governor and an automatic safety stop valve, insuring efficient operation, automatic control and positive safety.

Results prove that we have developed a simple pump of high efficiency—just the pump that power plant engineers need for their feed water supply.

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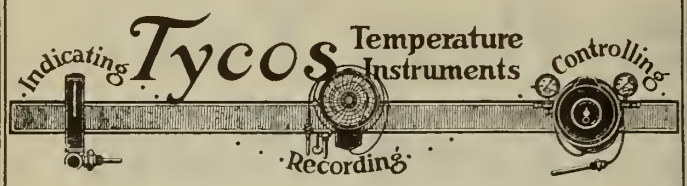

Thermometers Now Repaired in Canada

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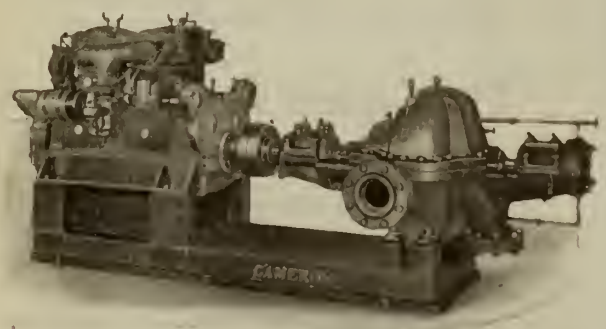

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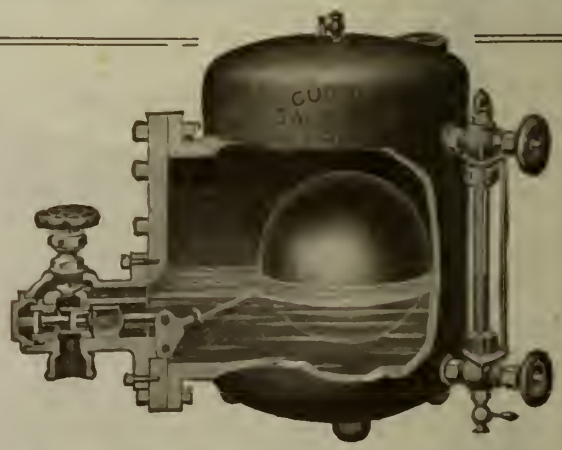

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"Canada Holds the Key"

Agnes C. Laut, in the May 15th issue of MACLEAN'S MAGAZINE, uses figures and facts that prove the future heart-beats of the great oil-burning leviathans of the ocean lanes will depend on the lakes of fuel that will be sucked up from the "basement" of Northwestern Canada. In an article, "Strangling Our Oil Goose," Miss Laut emphasizes:

"Canada has the oil. Canada holds the naval and merchant marine key of America. Edmonton in your generation and in mine will be a second Pittsburg. Great tankers will float out from Prince Rupert to supply the Orient. Tank cars will become as common across our prairies as grain cars. Our National Railways will—"

But you will have to read this talented author's article to get the picture she visualizes of the future of Western Canada when the development of oil resources of the North is at its zenith.

There is a strong hint in this article of Miss Laut's that Canada may "strangle her oil goose" by too much so-called caution. Read MACLEAN'S MAGAZINE, May 15th, and discover how Miss Laut argues that Canada will spoil her chances for control of the oil situation in North America and great wealth—if she *is not careful.*

A Tempting Array of Fact and Fiction

Take a peep into the May 15th issue of MACLEAN'S! Besides Miss Laut's article:

"He Who Laughs Last-----!"
By Frederick William Wallace

A thrilling short story of action. Setting, the Atlantic coast; characters, deep-sea fishermen. Written by the dean of deep-sea short fiction writers.

"Canada Counts Noses"
By Nicholas North

Did you know that the first systematic census of people and their wealth was taken in what is now the Dominion of Canada in 1666, and that system was later copied by all the greater world nations? Read this article on census-taking in Canada and learn all about it.

"Neighbor's Wooing"
By Francis Dickie

A race-track story in which you can fairly hear the rhythmical hoof-beats of the contending horses as they pound around the course. There's a beautiful, scheming young woman in this story and some plot!

"The Slant-Eyed Man"
By Leslie Howard Gordon

This is the second in the series of "The Gates of Tien T'ze" stories. There's mystery here that keeps you guessing right up to the climax.

"Pawned"

Another generous instalment of Frank L. Packard's mystery-romance.

"Peacock's Pinnacle"
By M. O. Hammond

Here's the absorbing story of a director of the Bank of England who "was once a barefoot boy" in the hills of Glengarry. Read how this barefoot lad, who built castles in the air, and by dint of his own efforts, made every dream come true.

"The Legion of the Lost"
By J. L. Rutledge

Why do men disappear? Sometimes it's premeditated action on the part of the individual, committed for the same reason as suicide. At other times it's accident—and then again, there are grim disappearances that are never solved. In real life the long arm of coincidence often plays a role that baffles the detectives.

"Our Lower Prices Bogey"
By Charles Christopher Jenkins

Who's to be blamed for the falling off in demand for certain necessities? What caused the slump in wages in many lines of industry? Read this article in which is described the "Deadly Circle" to blame for the passing depression. The article includes a resumé of the situation from leading employers and labor leaders.

"Son of the Clackmannan Giant"
By Stanley R. Hofflund

Do you like prize-fight stories? Maybe you don't care for the brutal sort, but here's one that is different of a prize-fighter with a soul and a woman at stake.

Review of Reviews

Included with this exceptional line-up of intellectual information and entertainment are the regular features of MACLEAN'S—the "Review of Reviews"—a comprehensive summary of the world's best contemporary short articles:

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Sir. Paul Dukes
Digging for the Missing Link.
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Finds of the Trawler.....A Trawler Hand

Interesting Views of Canada.
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Keep Your Boilers Clean

What the Sherwin-Williams Co., Ltd., largest manufacturers of paint in America, say about

MILLER'S BOILER CLEANING EXTRACT

R. C. Miller Oil & Supply Co.
Montreal.

May 5th.

Gentlemen:

Replying to your inquiry regarding results obtained from the use of your "Boiler Cleaning Extract" in our steam boilers.

We are pleased to be able to state that we have had entire satisfaction, and that this "Extract" has removed all of the scale from our boilers, and prevented any from again forming, and also that there has been no damage whatever caused to any part of the boilers, including the Tubes, Plates, Joints, Valves, Packings, or Brasses.

We find that it was a good investment as it reduced the consumption of coal, lengthened the life of the boilers and saved costly repairs.

Yours respectfully,
(Signed) Sherwin-Williams Co. of Canada, Ltd.

R. C. Miller Oil & Supply Co.
MONTREAL

Who was the Third Man?

WHEN the retirement of Sir Robert Borden as Premier of Canada was first announced, three outstanding men were considered as his possible successors. Their names were displayed prominently in every Canadian newspaper. The present Premier was of course one of the men mentioned. Sir Geo. Foster another. Who was the third man? You would remember him no doubt if his name were displayed prominently in the daily press to-day—but he has retired from the political arena, and his name is seldom mentioned.

How easily names slip from the memory when they cease to be given publicity.

There is a lesson here. If you wish your name and the name of your products to be remembered, you must give them constant publicity.

The prudent manufacturer of machine tools, power plant equipment, or industrial supplies of any kind places his name and the name of his products where they will be seen and remembered to best advantage: **in reliable technical newspapers.**

Reliable technical newspapers in Canada are those included as members of Canadian National Newspapers and Periodicals Association. Their circulation is bona-fide and their editorial practice is carefully guarded, in fact their whole policy must conform to the highest standards else they would not be eligible to membership in the association.

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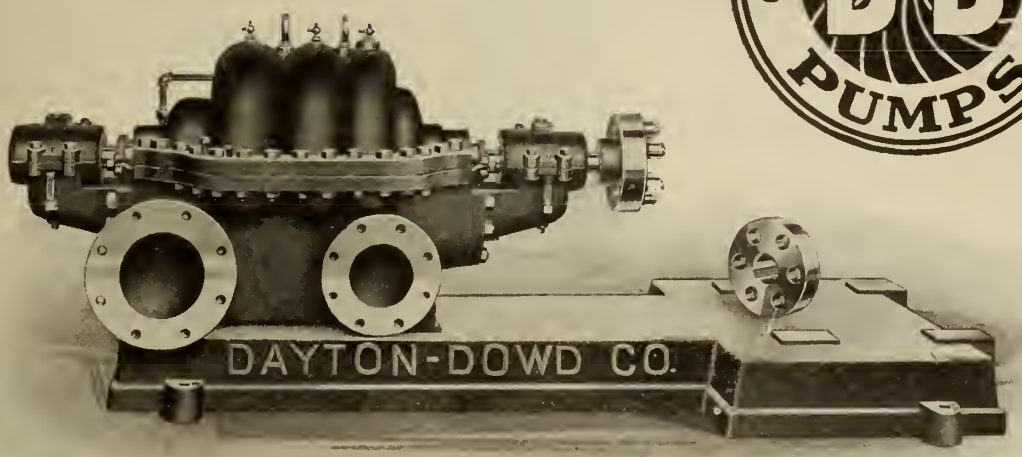

Type C.S.U. Automatically Balanced Three-Stage Centrifugal Pump

With Extended Bed Plate for Direct Connection to Motive Power

FOR service where the total head is beyond the range of efficient application of the Dayton-Dowd C. S. Single-Stage Pumps, the number of stages being dependent on the head and speed available to drive the pump.

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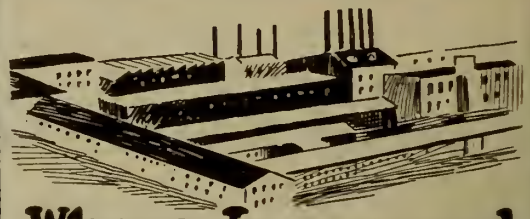
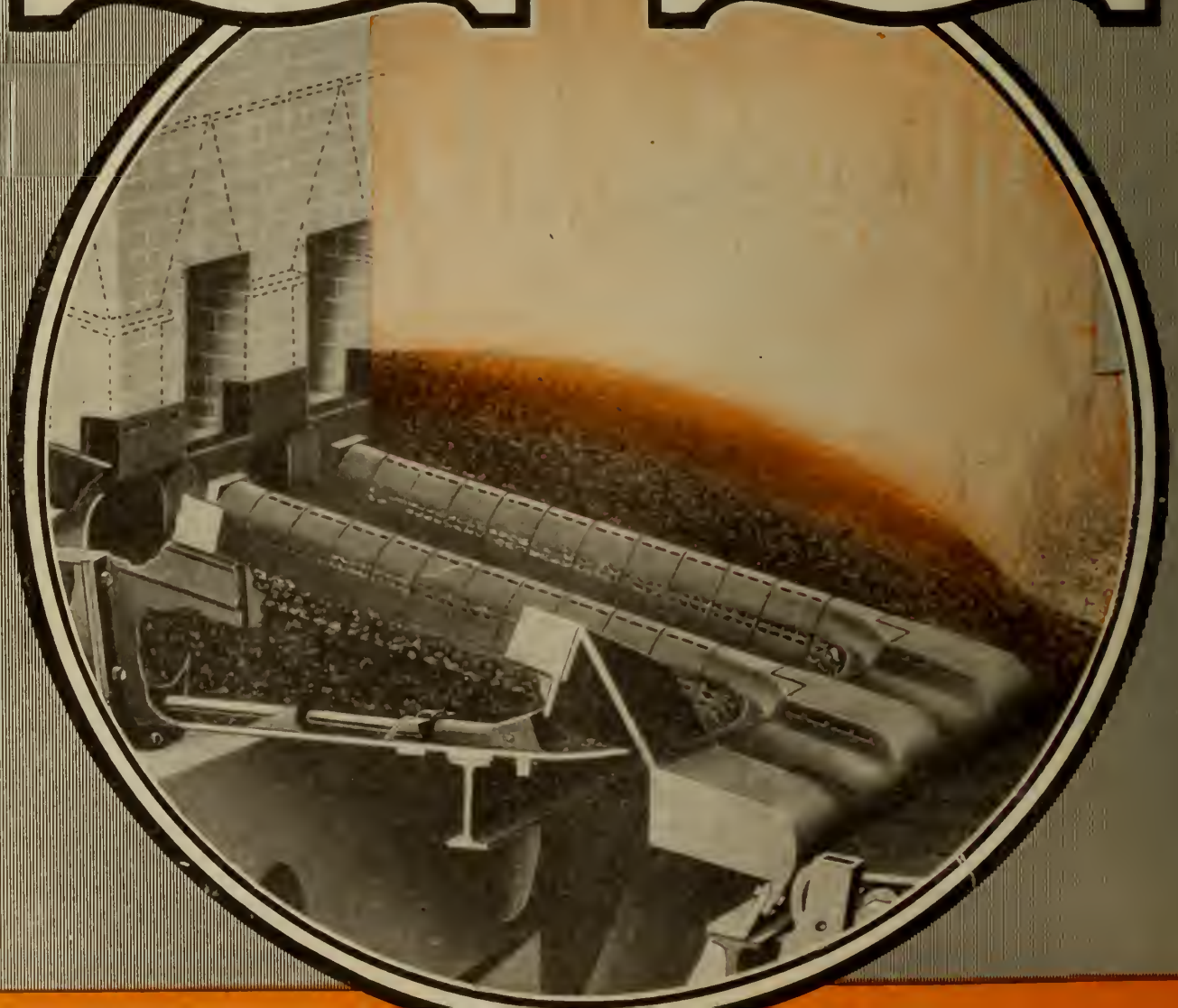
Where the Peak Load is the Rule

Canadian Central Stations and Public Utility Plants in general will find the Jones "A-C" exactly suited to the fluctuating load. The automatic control of fuel and air in the Jones "A-C," and individual control of retorts provide unequalled flexibility. From banked fires to 300 per cent. of boiler rating in a very few minutes is typical Jones performance.



Where Increased Production Calls for Continuous Over Loads

Large Canadian Industrial Plants operated at peak capacity will find the ability to operate continuously a marked advantage. The "automatic-cleaning" feature of the Jones "A-C" and the extreme simplicity eliminating shutdowns, permit continuous operation at high capacity. Two hundred per cent. of rating for 24 hours a day is regular practice in many Jones-equipped plants.



Your Plant?

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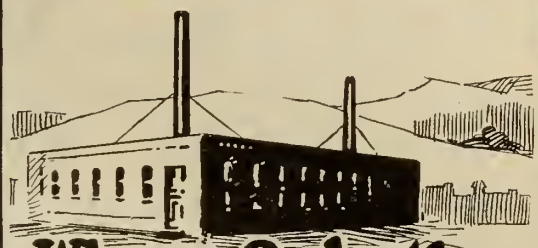
The Jones "A-C" is the ideal stoker where rigid smoke ordinances are in force. The under-feed principle of combustion, as originated and perfected in the Jones Stoker, insures smokeless operation. In the words of one Jones user, "We have boosted our load from 150 per cent. of rating to 340 per cent. in eight minutes without visible smoke."



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The stoker that combines the fundamental advantages of all types, while sacrificing the incidental advantages of none, is naturally the best for any plant. It is because the Jones "A-C" (Automatic-Cleaning) Stoker has had the advantage of 25 years of development by an organization comprised entirely of engineers—because our experience has covered every conceivable variation of load and fuel condition—because the under-feed principle, originated by this Company, has become universally accepted, that we claim the Jones "A-C" to be exactly such a stoker.

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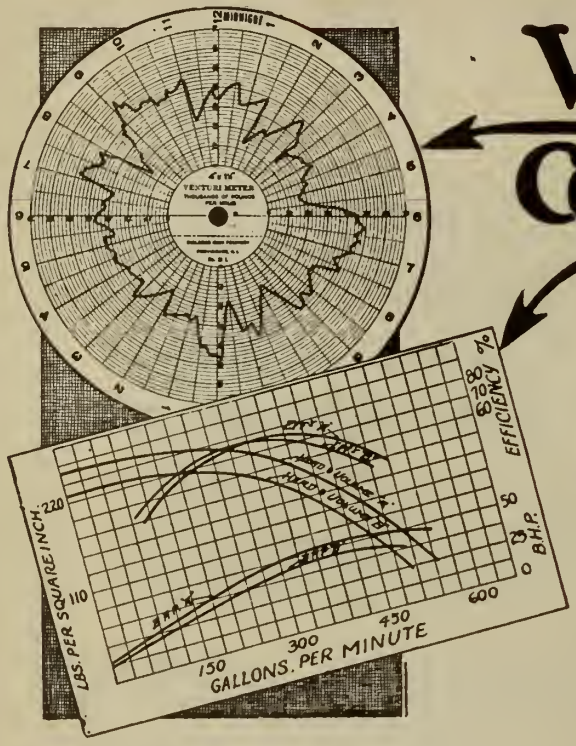

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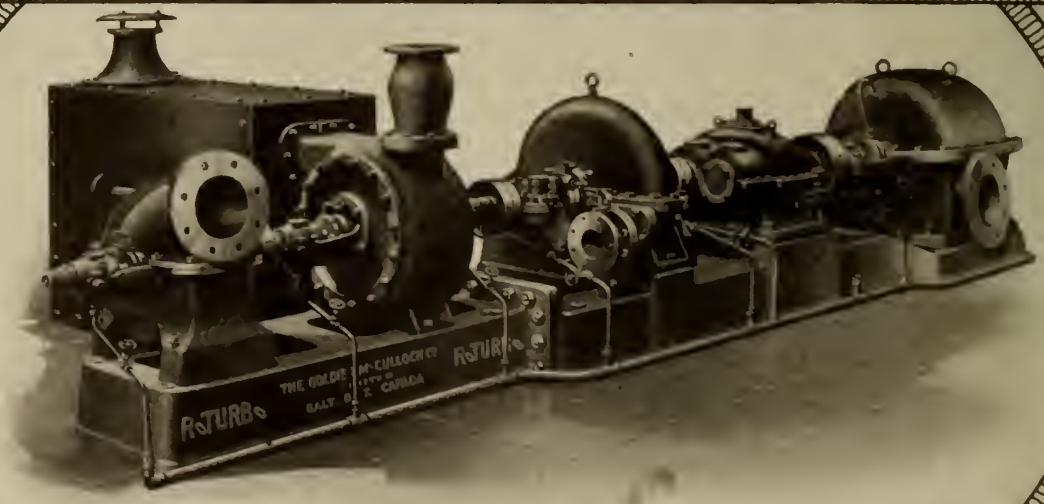

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Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
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A Course of Instruction for the Graded Certificate

Before Going Into the Analysis of Valve Setting by the Indicator Card, a Short Description of the Indicator is Given, With its Accessories

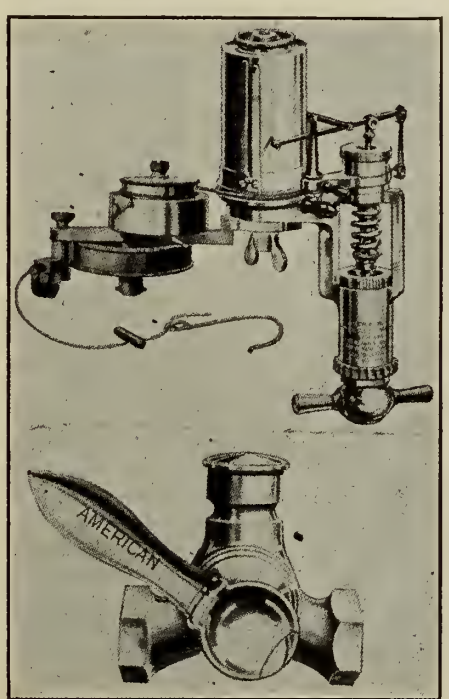
By T. H. FENNER

WE have described the general method of valve setting, preliminary to turning the engine over by steam and getting an indicator card. Before going on with the use of the indicator to determine valve setting, we will give a short description of the instrument itself.

The Steam Indicator

The indicator consists essentially of two distinct parts; the cylinder, which has a piston to transmit the expansive force or pressure of the steam to the recording pencil, and a drum, which is driven from the moving part of the engine. The drum is to receive the paper on which the diagram is traced, and it moves through a certain part of a revolution with every stroke of the engine. The length of the diagram taken depends on the arc turned through by the drum, and the latter is determined by the reducing mechanism of the indicator.

The action of the steam on the piston of the indicator is resisted by a spring, which is placed on the piston rod. These springs are of different degrees of resistance according to the pressure of the steam. Some are made so that a pressure of 100 pounds per square inch on the piston will compress them through one inch, others so that 80 pounds will do the same, and so on down through 60, 40, 20 and 10 pounds per square inch. The springs most frequently used are 80, 40, and 10, for high, intermediate and low pressure cylinders. The size of spring chosen should be such that a diagram about two inches in height is obtained, while at the same time the spring should not be weak enough to give sudden distortions of the pencil, or, to be plainer, violent jumps and drops. If this occurs, a misleading diagram will be obtained. Supposing you are about to indicate an engine carrying an initial pressure of 150 pounds per square inch, and you have springs of 80, 60, 40 and 20 pounds to choose from. An 80-pound spring will give a diagram about 1¾ inches high at its highest point. A 60-pound spring would give a height of 2½ inches, but the spring being light compared to the initial pressure, may give a momentarily



TYPICAL INDICATOR AND THREE-WAY COCK.

higher reading than the actual initial pressure. Then the 80-pound spring would be the one to use. If you want a card two inches in height, and have an initial pressure of 100 pounds, then you would want a spring $100 \div 2 = 50$ pounds. Probably you would not have one this size, the nearest being 40 and 60. It would be better to use the 60-pound spring, for the reason just given. On the other hand, if the spring used is too heavy, giving a low card, the various points of distribution will be more difficult to see.

The outline diagram here shown gives the general particulars of the indicator construction. The bottom of the cylinder is formed with a union connection, to connect to the three-way cock of the cylinder. The piston, which is of bronze, is made a neat working fit in the bore, and steam tightness is obtained by turning a small groove in the circumference. In an indicator with an inside spring, the spring is screwed on the base of the piston rod, and its other end to the cylinder cover. An extension or lug on the cylinder carries the drum for the card. The piston rod is connected outside the cylinder to the parallel motion which carries the pencil. This parallel motion is that invented by Watt for his pumping engines, and it gives the pencil point exactly the same motion as the piston. Sometimes the spring is placed outside the cylinder instead of inside, as in the illustration, and in this case the piston rod is extended to carry the spring, the link motion being just the same. The object of carrying the spring outside the cylinder, is of course, to get away from the action of high temperature steam on the delicate spring.

The drum that carries the paper is mounted on a central spindle, round which it turns. A spring is connected at one end to the spindle, and at the other to the periphery of the drum. When the drum revolves it coils the spring, and the spring brings it back during the return stroke of the engine. The drum is driven by a cord attached to the lower part of the drum, and wound round it a couple of turns, while its free end is attached to some part of the engine which has a reciprocating motion. If not attached direct to the engine, it is attached to some reducing apparatus which is in turn attached to the engine itself. As the drum is usually only about 1½ to 2 inches diameter, and it does not make a complete revolution, it cannot travel the same distance as the crosshead. It usually travels from 4½ to 5½ inches and the stroke of the engine may be from 12

to 48 inches, or even more. Hence the necessity of reducing motions.

Reducing Gears.

The means of reducing the motion of the crosshead to that of the drum are various, but the type where the gear is a part of the indicator itself is coming into general use more and more. This is quite natural, as it is by far the most simple and convenient.

In this arrangement, the indicator cord instead of being attached directly to the paper drum of the indicator, is attached to a pulley which drives the paper drum through a pair of bevel wheels. The pulley attached to the large bevel gear drives the paper drum, and this pulley can be changed to suit any engine from twelve inches to six feet stroke. The bevel gear spindle is attached to a spring which brings it back to starting position in the same way that the drum is brought back.

The crosshead motion may also be reduced by means of a lever attached to the crosshead itself, and if the indicator is not supplied with a geared-reducing motion, this is about as good a way as can be used. The top of the lever is pivoted to a bracket made on the frame of the engine, and the lower end is driven by a pin from the crosshead. The great point about the geared reduction device is that there is no point for any lost motion to take place, and the motion of the drum exactly coincides with the motion of the piston. Whatever method may be used for making the reduction, care must be taken that there is the least possible chance for lost motion.

Taking the Card

One of the points that beginners find awkward is attaching and detaching the cord to the moving part which drives it. This is especially the case in fast-running engines. There is no great difficulty if the cord is properly arranged, and a little practice will soon make the average man proficient. When the motion is driven directly from the crosshead on a high-speed short-stroke engine it is of course more awkward than on a slow speed long stroke engine, where a lever of some kind is perhaps used. However, this is one of the things we believe must be learned on the job, and cannot be taught through the written word. To those who have not yet taken a card, we can only say, "Get the chief to show you how."

Before taking a card the indicator should be warmed up by opening the indicator cock very slightly, and allowing the steam to enter the indicator cylinder. Leave it like this for 15 minutes or longer, till the indicator has got thoroughly heated up all over, and the pipes from each end of the cylinder to the three-way cock are thoroughly clear of moisture. Then shut the cock, and place the card on the drum. Next attach the cord to the driving motion, and without opening the three-way cock, place the pencil on the drum and a line will be drawn. This is the atmospheric line, or the line that represents a pressure of 14.7 pounds absolute. It is the datum line from which can be set off by means of the scale the absolute zero, or vacuum line. This line must never be omitted when anything in the nature of calculations are to be performed on the card. Even if the card is to be used for observing steam distribution only, it is better to have the line on, and as a matter of fact, it becomes a habit to always place it on the card first thing. It is a good guide as to whether the pencil is set right before taking the card, that is, set so as to make a clear definite mark.

When taking the first card, after the atmospheric line has been made, it is a good plan to disconnect the cord again, and examine the position of the atmospheric line with reference to the length of the card.

It sometimes happens if the length of the driving cord is not quite correct, that on the inward stroke of the engine the drum comes to rest against its stop before the crosshead has completed its inward stroke. It may be such a small fraction of time that it is not noticed, but it can be checked up very nicely by the atmospheric line. Pull the drum around by hand, and then allow it to go back slowly, keeping the atmospheric line in view and the pencil point resting lightly on it. If the end of the line reaches the pencil point before the drum has reached its stop, you are all right. If, however, the drum comes up against its stop at the same time that the line end reaches the pencil point, then the cord must be shortened. Sometimes a very straight steam line is due to this cause and this only. The engine stroke must be finished while there is still some movement in the drum, to get a true card.

Having satisfied this condition, the cord can be again connected, and the cock opened to the cylinder. The pencil is pressed lightly against the card, and kept there for a couple or three revolutions. The cock is then opened on the other end, and the same thing takes place. The cock is closed, the cord disconnected, and the card taken off the drum. We can now see how close the valve or valves are to being set correctly, providing we can correctly read the message the card can give us.

TESTING CENTRIFUGAL PUMPS

In the current isssue of Beardmore News there is described the method by which centrifugal pumps are tested in the Coatbridge works of Messrs. William Beardmore & Co. The pump is driven by a variable speed motor, so that any test speed desired may be obtained. By reading the electrical power input and using it in conjunction with the certified efficiency curve for the motor, the actual brake horse-power given off by the motor is ascertained. The volume delivered is measured most accurately by a method introduced and brought to perfection by the late Professor James Thomson, of Glasgow University. In this method the water flows from the tank over a right-angled V notch, the quantity passing depending on the height of the water surface over the apex of the notch. In the Beardmore test plant the water from the delivery pipe flows into the end of the tank remote from the notch, passes through three fine wire screens about one foot apart, and then flows steadily down the tank and over the notch. The screens take all surge and eddy motion out of the water, with the result that the flow over the notch is perfectly steady. The height of the water level over the apex of the notch is accurately measured at a point three feet back from the notch, so that still water conditions are obtained, and the readings are not rendered inaccurate by the fall of water level in the immediate vicinity of the notch. The device for measuring the height is calibrated direct in gallons per minute, in accordance with formulae devised by Professor Thomson.

Very instructive results, it is added, may be obtained from exhaustive tests of pumps on well-arranged and reliable test plants, such as that described, and it is owing to such tests, in conjunction with careful and intelligent design, that the efficiency of the centrifugal pump has been raised from the 40 per cent. which was common a few years ago, and still obtains in some designs, to the much more satisfactory efficiencies of to-day.

THE SILENT EXHAUST

The problem of silencing the exhaust from internal combustion engines has engaged the attention of engineers for many years and countless devices have been invented, with more or less success, for the purpose. Hitherto the appliances required for the marine type of internal combustion engine have occupied a good deal of space and added considerably to the weight of the vessel. In order to overcome these drawbacks a British firm of engineers has devised appliances in which the energy of the exhaust gases are used to put in motion a comparatively large body of cooling water or air. The exhaust gases are forced to come out from below a large spring-loaded valve in a stream between two plates under water, inducing the water to circulate and cooling themselves at the same time. The only resistance offered to the flow of the gases is the light resistance of the spring and of a few inches of water, so that very little back pressure is exercised. Where air cooling is used, a similar principle is adopted. Both types have been successfully at work for some time, the former on engines up to 10,000 brake horse power and the latter on engines of 1,500 brake horse power.

Practical Points on Steam Turbines

Operating Features of Steam Turbines—Warming Up—Function of the Relief Valve—A Turbine Explosion—The Gland Packing —End Play—The Emergency Governor

By J. A. McGILLIVRAY

A FEW remarks on the operation of turbines may interest the engineer who may not just now have turbines in his charge, but may later on. I would advise him to buy a book on steam turbines if there were any that could be recommended for the operator on the job. If there are such books I never saw them. There are a great many books "and excellent ones at that" which tell you all about how they are built and how designed for economy and all about the method by which the steam is expanded through successive stages or in a single nozzle, etc. I am not taking that matter up just now, because the operator when he has the turbine as part of his equipment is most concerned with successful operation and least concerned with the particular features of design.

First let me say that there are no two steam turbines in existence that have the same peculiarities, any more than there are any two people having the same nature, but there are many things that are common to all steam turbines and some of these things we will discuss.

Warming Up

To warm a turbine up before putting in operation, or bringing her up to speed, is an entirely different operation to warming up the engine. The engine must be warmed up before starting, but the turbine should be warmed up running, or turning over. The reason for this is that it is impossible to get equal temperature or nearly equal temperature if the throttle or by-pass of a turbine is cracked open and steam allowed to the condenser or to the atmosphere. The result of this method is distortion that seriously affects the running of the machine, by throwing the parts out of alignment. You will understand that the clearances in steam turbines are very small and the alignment must be almost perfect. In fact it is as nearly perfect as experts can make it.

The Correct Procedure

First, look to the oil. If you are depending on an oil pump separate from the machine for starting purposes you should first start the oil pump. If it is a condensing job we will assume that your condenser auxiliaries are going. You may have anywhere from 2 inches of vacuum to 10 inches before you start. Now you have the oil pump going and you note your oil pressure. (In some types the governor does not open or raise until the oil pressure is built up. This is a good thing, as you can't start the turbine without the oil pump.) When you have attended to this and you see that the oil is flowing properly, open the throttle out sufficient to start the machine quickly. Don't waste time at the throttle cracking it open, little by little, as the longer you take getting the turbine turning over the more harm you are doing. Open up promptly (two or three turns), if it is a machine of any size it will be draggy or tardy to start but once she moves off you must be ready to close your throttle down until it is just cracked off the seat as by the time you do this the turbine is revolving at anywhere from 100 to 300 r.p.m. and this is just about right for warming up. Now don't let your vacuum build up too fast, because with a high vacuum and no load the machine will come to speed quickly; this is not desirable. If the turbine is used for propulsion you will have load and it doesn't matter about the vacuum, that is you may build the vacuum right up and control the turbine from the throttle. Now with the turbine turning over at 200 or 300 r.p.m. you can let her warm up for anything from 10 minutes to 30 minutes depending upon the size. In the meantime look to your oil flow and if O.K. and the machine warmed you can now bring the machine to speed and this is where some turbines differ greatly in the manner of bringing them to speed without vibration. There are two critical speeds, that is, two speeds where they vibrate, one is below the normal running speed and one above the normal running speed. Now in coming to normal speed the machine must pass through the first critical speed, and at this point the vibration may be little or great, it depends upon the peculiarities of the type. If the machine is not properly carried over this point it will be necessary to shut down completely and start over again or run the machine in a vibrating condition that may be a long time quieting down. I have seen them vibrate more or less for 30 hours when put in in a hurry or unskilfully manoeuvred through the first critical speed. The proper way to do this can only be learned from practice. Some machines must be brought over the first critical speed quickly and steadily accelerated, probably the acceleration over the critical speed will be too great to allow it to continue up to normal, so after the machine has passed that speed you will be obliged to check the acceleration, as you mustn't let her on the governor too suddenly as this causes a sensitive governor to swing or hunt. I've seen them swing from dead closed to wide open and keep going that way until the throttle was partly closed and the result is lost time and probably a vibrating or rough running machine and a good chance to get a slug of water.

Some machines can be accelerated steadily from the warming up speed to full speed, but you should try every kink you know of to bring the machine into normal speed quietly before you decide that the balance is imperfect as 50 per cent. of the rough running turbines are thus because they are not properly warmed up and brought to speed as they should be.

Before going this far I should have mentioned that you should close your auxiliary oil pump down as soon as the speed of the turbine was sufficient to maintain normal oil pressure by the gear driven oil pump. The oil pressure also has a great deal to do with the quiet running of a turbine. If the oil pressure is too high or too low it will cause vibration. You will notice that the oil pressure may be several pounds too high, or higher than normal, when you first start up, but falls off when the oil warms up to running heat.

The oil pressure also falls off when the strainer gets dirty. You will usually notice vibration or a change in the sound of the machine when the oil pressure changes.

Small sizes of turbines are frequently ring oiling and some sizes up to 1,000 horsepower depend upon ring oiling only when starting up. That is there is no auxiliary pump. It is extremely important to get those machines away from rest rather quickly so that the rings will turn with the shaft. If you start the machine revolving slowly the rings may not turn and remembering that there is absolutely no oil under the shaft when the machine is first started the bearing lining will suffer more in ten minutes if the rings don't turn than in ten years of normal running under oil pressure, because under normal oil pressure the shaft does not touch the lining at all. I've seen linings that were in use for eight years that the scraper marks were to be seen as plain as if they were made an hour before.

Remember the Relief Valve

Now there is another important thing to remember, that is the relief valve on the turbine casing or on the condenser, and in stationary jobs usually situated in the atmospheric exhaust line near the condenser. This relief valve should never be neglected and no turbine should

be installed without a relief valve where there is any chance of obstructing the free exhaust. The reason is that the turbine casing is not built for internal pressure. It is only a thin shell of cast iron and should the free exhaust be obstructed the pressure will surely build up in the casing and blow it to pieces and I have known it to kill the engineer and wreck the engine room. This happened a few years ago. The engineer was closing the sluice valve from the turbine floor, standing beside the machine (a Curtis) carrying a light load. He intended to start up in the morning non-condensing and as the shift was about finished he was changing to non-condensing in order that everything would be set for the morning. The atmospheric valve did not open and the machine went up, killed the engineer and wrecked the plant.

In normal operation the pressure in a condensing steam turbine casing when the machine is fully loaded is less than, or at least not greater than, the atmosphere, in cases of momentary overload the pressure in the casing may be one or two pounds above atmospheric, in a non-condensing turbine the maximum may not exceed 5 to 10 pounds, and is usually less, but the non-condensing turbine casing is made stronger. Some turbines are of the bleeder type and are built to stand a pressure of probably 50 per cent. of the boiler pressure but those are special cases.

Now the difference between getting power from a steam engine and a turbine is this. In the former we get the power from the mean effective pressure on the piston and the engine cylinder is made strong enough to withstand the pressure so if the exhaust valve is closed off we can't blow the cylinder up, we will simply choke the engine off and she will stop.

In the latter case we get power from the turbine wheel by letting the steam impinge on the blades at a high velocity. The steam presure is greatly reduced in order to increase the velocity. Now a body (the steam) in motion has kinetic energy and this kinetic energy is given up to the wheel. Now if we close the sluice valve to the condenser and there is no relief valve we build up a pressure in the casing, the limit of the pressure we can build up is the boiler pressure.

A Turbine Explosion

There was only one case of turbine explosion that ever came directly to my notice, and how the engineer escaped alive is more than I could ever tell. It was a miracle. I viewed the wreck next morning and there was nothing left of the turbine casing except the sole-plate that it rested on. It happened this way. The night engineer was starting a 25 k.w. exciter set and some one throughout the day closed the exhaust valve when making other repairs. There was no relief valve and when the engineer turned the steam into the turbine the casing exploded. The engineer did not get hurt much but the exploded casing went in every direction.

I received another lesson about three years later that may interest engineers, in a stationary plant where we had turbines as well as engines, compressors and pumps. We had a good deal to look after and were running most of the time seven days a week and twenty-four hours a day and our turbines were the least of our troubles. In fact they were so satisfactory that we probably got careless of the turbines in our solicitude for the other apparatus that required constant attention, and of which we had no duplicates. We had then two large turbines and one small 150 horsepower stand-by for lighting, etc. One night the night engineer lost the vacuum on the turbine set, owing to unusually low water. The air pump was a Blake Knowles 20 inches by 12 inches air cylinder driven by a 10 inches by 12 inches steam engine. If you happen to know the Blake Knowles air pump you will know that the air valve is nothing more than a (D) valve with an extra port or by-pass, but the function is just the reverse of what the (D) valve performs in a steam chest. In order to let the air exhaust to the atmosphere there is a thin steel plate (feather valve) on the back of the main valve, seating against a grid when the air cylinder is taking a charge from the condenser, and opening outward when discharging the air.

When the engineer lost the vacuum the oiler happened to be in the basement oiling the air pump when all at once the engine began to run away. The oiler of course went to shut down, and showed his presence of mind by tripping the governor which was a trigger affair, but the engine went faster than ever and before the engineer of the watch had the sluice valve to the condenser closed the air pump was a wreck. Well, when I got the whole story next morning I couldn't tell which of them was lying, but I thought one of them was, but for the liking I had for the oiler and the faith I had in his honesty I'd have never found out what happened, because I had my mind made up that the oiler must have been walking in his sleep and poured oil on the governor belt and that they invented the yarn for me. However, after having another talk privately with the oiler I felt that he told me the truth, but what happened was to me a mystery for some time. We repaired the engine and I used to go down there sometimes and look at the layout and try to make it out. I was just about to let it go as an unsolved riddle, but when I am dead up against a thing I have a habit of sitting down and making a sketch of the layout, whatever it may be, and studying it out on paper. So this day I made a sketch of the air cylinder and valve and at once I could see it all. When the engineer lost the vacuum a pressure built up in the condenser before he got the sluice valve shut off. (It took five minutes to close one of those valves by hand.) The relief valve which was supposed to relieve at ½ pound was sticky and the machine full loaded. The pressure in the condenser must have been 8 or 10 pounds and the air pump cylinder became a steam cylinder with a D valve cutting off the steam. No control on the engine as the governor was useless. The air pipe from the condenser to the pump was now a steam pipe. The low pressure steam acting on the 20-inch air piston drove the engine to pieces in a few minutes. I knew very well that ½ pound pressure would not drive the engine over speed and investigated and found the relief valve sticking.

The Gland Packing

There is another thing that gives trouble or worry and that is the gland packing seal on the shaft. Very small sets are packed with fibrous packing and sometimes with semi-metallic packing, large sets are almost without exception packed with metallic or carbon rings that just clear the shaft. The rings are in sections and are arch bound so that they are held in place in a groove and together by a garter spring and all called the labyrinth type. The packing does not make an air-tight seal but the exclusion of air is accomplished by using steam or water to seal against air. When sealed with steam there is usually a reducing valve in the steam seal line to maintain a constant low pressure of about 10 pounds per square inch. The leakage along the shaft is drawn into the condenser and is available for make up feed water. If the amount of steam admitted to the seal box is not nicely regulated it will result in a cloud of steam blowing away from the turbine and a loss that must be made up to the feed supply, or if too little is admitted the result is a low vacuum.

With water seal there is not much trouble until the seal box is worn badly, when it can be removed. If the packing is good there will be little or no water get over to the condenser steam space, but when worn there will be a considerable amount. The action is as follows. The water admitted is given a revolving motion by the rotating shaft, which hurls a solid ring of water around at the same speed as the shaft. The friction of the water revolving against the stationary element is sufficient to heat it to the vaporization point in a short time, unless a certain amount is being continually supplied. In order that the centrifugal force will not force the water entirely out of the gland the discharge is carried up about 20 feet so that there will always be a head of about 10 pounds to be pumped against (you may consider the revolving shaft inside the seal box as a rotary pump).

In small sets where fibrous packing is used there is sometimes an attempt made to lubricate the shaft, with vary-

ing degrees of success, and in some cases none whatever. The packing should bear as lightly as possible on the shaft since it will cut the shaft in a short time and besides if it tends to grip the shaft it will cause vibration and any unevenness in the packing or the gland will cause misalignment of the revolving element.

End Play

The end play is adjusted by shims or a geared nut that is advanced or backed up by a worm. The end play varies in some machines but the total end motion is between 11 and 22 thousands with the average in moderate sizes about 10 thousands. This end motion is divided after the machine is assembled, that is when the motor is revolving it is advanced toward the stationary blading until it just rubs, then brought back until it again touches. The total movement is marked and divided, for example if the total movement is 16-1000 the thrust bearing is locked where the clearance is 8-1000 each side of the revolving blades. The clearance between the casing and the perimeter of the wheel is somewhat greater and is greater in large sizes than small sizes, on account of the greater distortion due to temperature.

There is a very great temperature range from the high stage of large sets to the last or low pressure stage. The temperature at the turbine inlet is that corresponding to superheated steam, and in the last stage that corresponding to a high vacuum. Thus there are in large sizes that are not compounded severe strains and distortions in both the revolving and the stationary elements. It would appear that compounding of large sets has to some extent eliminated or at least simplified those stresses and the clearances can be adjusted closer than if in one large unit expanding the steam from the initial pressure down to the condenser pressure.

Emergency Governor

The emergency governors of all steam turbines are fundamentally the same, though differing in construction details. The throttle has on its stem a sliding sleeve that is engaged by a trigger or pawl which is connected through links to another pawl, mounted on the front bearing, an eccentric ring, or a plug (depending on the maker's particular construction), is so attached to the revolving shaft that it revolves with it. It is held in toward the shaft center by a spring. The spring tension is so adjusted by trial that at normal speed of the machine the trip just clears the pawl or trigger, but when the speed is increased about 8 per cent. over normal the centrifugal force overpowers the opposing spring and the ring or plug projects from the revolving shaft and trips the pawl, which in turn disengages the sliding sleeve and the unbalanced pressure on the throttle causes it to close instantly closing the machine down. There are various forms of construction but this description wil assist the engineer to follow out the important details of the particular kind he may have under consideration, bearing in mind that in all cases the centrifugal force of a revolving weight must overpower some other force in order to trip the emergency, and the opposing force is usually an adjustable spring. Great care must be taken that the connecting links from the throttle to the emergency trip do not bind or that the knuckles and joints do not become clogged up with dirt or paint. It is better to keep them bright and the throttle packing gland should never be too tightly packed, as this may cause it to bind.

The turbine should be allowed to over speed occasionally when not loaded in order to make sure that the emergency will trip and close the machine down. This can be done by holding the governor and observing the tachometer or speed indicator. The emergency should work at 8 or 10 per cent. above normal. If it does not it is not advisable to allow the speed to go much higher. I would say 14 per cent. would be the limit, as the second critical speed may not be far from this value and the machine might go to pieces. Of course, it might not do so, but that is too uncertain. It is just like letting your boiler pressure go above the safe working pressure. It might blow up or might not.

ROLLING MILL ENGINE

What is claimed to be the most powerful rolling mill engine in the world is now in course of erection in a British steel works. It is intended to drive a train of 32-inch finishing rolls for large sections of steel. Some idea of the enormous size of the engine may be gained from the fact that the face of a man standing on the ground just comes to a level with the crank shaft—the engine being a vertical one. The maximum horse power developed is 25,000 at a speed of 140 revolutions per minute. There are three cylinders, each 45 inches in diameter, and with a stroke of 52 inches. Joists up to 24 inches deep and 12 inches wide will be rolled in this mill. The makers have given a guarantee that this huge engine will be capable of reversing four times in one minute, and they are confident that the engine will do better than the guarantee. This rapidity of reversal, which is of great value in increasing output, is secured by a most ingenious system of valve gears. The engine is carried on a massive concrete foundation with an iron casting two feet deep—weighing over 100 tons—embedded in it. Small auxiliary engines are used to operate the reversing gear, also the stop valves.

CANADA'S COAL SITUATION

Canada created a record for coal production in 1920, when she produced 16,968,658 short tons, as against 13,919,096 short tons in the preceding year, or an increase of 21.9 per cent. The previous high mark was set in 1913, when the output totalled 15,532,878 short tons. Exports increased to 2,558,223 tons, as compared with 2,070,050, but this was counter-balanced by the increase in imports from the United States from 16,982,773 to 20,815,596. The total value of production is estimated at about $70,000,000.

With only one exception, that of Saskatchewan, every province of the Dominion exhibited an increase in production during the year over the 1919 figures. A particularly interesting feature of the year was the wresting from Nova Scotia by Alberta of the honor of premier producer, the Western province leading the Eastern by nearly four per cent. Alberta produced 41 per cent. of the total output, or roughly 6,700,000 tons; Nova Scotia, 37.8 per cent., or 6,500,000; British Columbia, 18.3 per cent. or 2,550,000 tons; Saskatchewan, 1.9 per cent., or 330,000 tons; and New Brunswick, 1 per cent., or 170,000 tons. The reduction in Saskatchewan's output is attributed to the greatly increased use of Alberta coal in Manitoba and that province.

A both interesting and gratifying feature of the coal situation in 1920 was the increased use of native coal, especially in the Prairie Provinces. The war, which cut down shipments of anthracite from the United States to Manitoba, gave Alberta her opportunity to introduce her product on the qualities of which there was a lack of education. She was not slow to force her way, and is maintaining the position assumed with every indication of increasing her market. This is shown very clearly in the shipments of coal from Alberta eastward, which in 1920 totalled about 500,000 tons as compared with approximately 250,000 tons in 1919.

TESTING ENGINE CRANK SHAFTS

When an engine is built, one of the items to be tested is whether the crank shaft is in strict alignment; and in order to ensure the satisfactory running of the engine, tests with a similar object should be made periodically. A British engineering firm recently introduced a new instrument for making such tests accurately and rapidly. It consists of a dial divided into thousandths of an inch and a pointer actuated by a plunger which juts out at the top of the dial. Flanking this plunger are two spring plungers; the dial is carried on a column which screws into a base. The apparatus is used—in a manner which cannot be described without technical details—to measure the distance between the inner faces of the crank balance weights or of the outer ends of the crank webs, first when the shaft is in one position and next when it has been moved through half a revolution. If the pointer shows a movement to one side or the other it proves that the alignment is not perfect. This instrument is made either non-adjustable, for only one size of crank shaft, or adjustable for any sizes in which the distance between the web is not less than 4½ inches or more than 9½ inches. It can be used for either horizontal or vertical engines.

Overhauling and Adjusting in the Engine Room

The Importance of Keeping Things in Their Proper Place, and Having a Place to Keep Them—Have Proper Spanners for Awkward Places—How to Overhaul a Pump

By "FITTER"

WHEN the young man who is starting in to become a first class stationary engineer graduates from the boiler room to the engine room in the ordinary course, he has a lot to learn. One of the principal things he must become acquainted with is the overhauling and adjusting of the main driving units as well as the auxiliaries. He will at first get only such jobs as packing glands, pistons of pumps, renewing valves in the water ends, etc., but the time will come when he will have to tackle bigger jobs. He will at first be under instructions from some more experienced man, or perhaps be just assisting such a man, and if he knows something about the methods employed by those who are old at the game, it will prove a help to him in his progress towards the top.

There is never any lack of work in an engine room, even if it consists of only a single cylinder non-condensing engine driving the factory through a belt. There will be no lack of work here, because there will usually only be one man to do all the work there is. Similarly, as the plants get larger, there will still be about the same amount of work to each man, so that one does not have to look around very much for jobs that require attending to.

A Place for Everything.

One of the first things the young engineer should learn is to have the necessary tools for each job handy to that job, and if the same tools are used for several different jobs, to have them in a convenient place, and to see that they are put back immediately after being used, and not allowed to kick around until they are lost. There is real pleasure in doing a job if the tools are ready to hand, and do not have to be hunted for before the job can be started. When they can't be found, and makeshifts are pressed into place, the job is only half done, and every one is dissatisfied. It has been my experience that this is one of the great faults met with in many men in the stationary engineering line, and it is a very bad one. In every engine room that good old motto should be painted or engraved in plain sight of all hands, "A place for everything, and everything in its place."

Every piece of machinery in the engine room, when originally sent out from the factory, had its own spanners and wrenches accompanying it, made especially to fit the nuts made by the maker, and very often if not invariably made in special shapes to fit special awkward corners. Into how many plants of two or three years of age can one go, and find the original spanners and wrenches that went out with the job? Very few, it is to be feared. On the other hand, I have seen ships of ten times that many years' service, with all the original spanners that were in them when they were built. It is just as easy and easier to do this ashore as afloat, if the same interest and care is taken in the job.

If the original spanners have been lost, the next best thing is to get others made, as experience dictates will be the most suitable for the particular purpose. It is rarely that a spanner cannot be made to fit the most awkward nuts, and kept in a rack over the particular pump, air compressor or engine that it is meant for, or if not there in the store room in a special rack. Spanner racks are easily made from a piece of angle iron and fastened on the wall or the frame of the machine itself. This applies very particularly to those special wrenches for removing the studs of the water valves in pumps, which seem in many engine rooms to be always missing when required.

We will suppose for the purpose of getting a start, that the water end of an ordinary duplex pump is to be examined, to ascertain the cause of the pump not performing its duty properly. The first place one would examine would naturally be the valves, and these would be in some types of pumps easily got at through the hand holds, while in others it will be necessary to remove the discharge valve cover entirely. In either case nuts will have to be removed, and here is a place where a good habit can be formed. That is to always string nuts as they are taken off on a piece of wire or string in such a way that they can be placed back on the same studs or bolts from which they were removed. Careful observance of this habit will reduce the time required in trying to force bad fitting nuts on to threads they don't want to go on. If the nuts are strung, then the last nut to go on the string will be the first nut to be replaced on the last stud, and the opposite way round will be used when placing the nuts back. Besides this, the facts of having the nuts on a wire or string will prevent them slipping down into the pump or under the engine room floor, where they can't be found when the job is finished. It takes a little time perhaps to have the wire or string ready, but it saves a great deal more time in the long run. How often does it happen that a job is all fixed up and ready to be put in service again, while all hands are scurrying around to find a nut to fit, the original nut having mysteriously disappeared. When the nut is found, it is a different size over the flats to the nut on the job, and that abomination of any real mechanic, the monkey wrench, is brought into play. It has always been a source of wonder to the writer that a tool so essentially awkward could ever attain the popularity it seems to enjoy. The number of barked and bruised knuckles it is responsible for must be enormous, to say nothing of the nuts it has spoiled by slipping round the edge. It is a good enough tool perhaps for the boy who owns a bicycle, or a pair of roller skates, or for the carpenter who is handy at doing odd jobs, but in an engine room it is not the right kind of tool.

The usual duplex pump is fitted with hard or soft rubber valves, held in place by a stud with a hexagonal top, which forms a washer for the spring to work against. The chief difficulty encountered with the valves is that of the valves themselves breaking, the studs breaking off, coming loose in the seat or the springs breaking. The length of time they will last depends a good deal on the care expended when putting them in. First of all the springs used should be of the right gauge of wire and of the same number of coils as the original springs, or very closely approximating them. A spring with too much tension produces undue wear on the valves, and too light a spring allows too much lift and shock producing the same effect. Frequently the brass studs which were supplied with the pump are replaced by ordinary iron studs or bolts with washers to keep the spring in place. This results in the spring being misplaced after a very short time of working, and the valve soon shows signs of uneven wear. Putting in valves with too large a hole for the stud results again in the valves playing about the seats, the hole speedily becoming oval, and the life of the valve being shortened. If the thread in the seat appears to be worn, tap it out a larger size and get a special stud made to fit it. Do not put a stud in that fits loosely in the seat, as that means that you will have to open up the pump in a very short time. If the valves are good on one side, they can be turned over and used again, and if they are broken round the edges it may be possible by trimming them to use them again in a smaller pump. Remember that engine room supplies are expensive, and the more wear you can get out of material, the cheaper you are furnishing power.

If it is necessary for any reason to

remove the discharge valve chest cover, to reach the suction valve deck, and if this deck is also lifted for any reason, pay particular attention when replacing them to making a good joint between the suction valve deck and the body of the pump, as if there is any opening here the pump will draw air, and lose its efficiency. If the joint on the discharge valve side is bad you will be made aware of it by the water spurting out. If the faces of the castings are clean, a good joint can be made with a piece of flat lamp wick rubbed in tallow. Wool yarn, such as is used in siphons, wound round inside the studs will also serve the purpose, and is much easier to make and cheaper than using a rubber gasket. If rubber is used the upper surface nearest the cover should be well rubbed with graphite, so that when the cover is lifted, it will come away freely from the joint, and leave the rubber sticking to the suction valve deck. Making a rubber joint to cover the whole face inside and outside the studs on a big pump is a waste of rubber, because the part outside the studs is merely waste material. When tightening down the cover, go very carefully, tightening down the nuts in the centre a little first, following with the nuts at each corner a little at a time until the cover is down absolutely square all over. You can then tighten up by going all round one nut after the other, not putting too much tension on any one of them till they are all firmly embedded. Then go round them again and give them the final tightening. If the nuts have been all evenly treated, there will be not very much more to be got on them at the final round. Don't make the mistake of trying to see how hard the nuts can be pulled. There is no need for it, and you are only straining both yourself and the pump for nothing. Remember there are usually enough nuts on the cover to get the requisite tightness without undue strain, and if the joint is leaking after the ordinary tightening, it is best to remove the cover and see if there is a piece of dirt in one spot, or the joint has been broken in placing the cover on. If the joint is not properly laid on, you can tighten until you break something without stopping the leak altogether. Remember in all overhauling work, to refrain from making it a test of strength. Engineering appliances are made to fit, and do not need to be forced except in a few cases.

There doesn't seem to be a great deal about replacing a valve in a pump, but it has to be done properly, unless it is going to require replacing again in a very short time. This means that the valve must be a good working fit on the stud, neither slack nor tight. The stud must be of the proper length, a good fit in the thread of the seat, and not depending on the last turn to make it tight. The spring should fit under the hexagon head of the stud and on the shoulder made on the stud to receive it, so that it will be kept vertical and thus prevent the valve from coming down on the seat unevenly. The spring itself should be the right size wire and the right number of coils and not just any kind of a spring that happens along. The seats should be examined to see if they are true, and if found to be warped or worn, the easiest way is to take them whole deck out and face them up to a surface board on the bench. If there is a machine shop in the factory, get them to put the deck with the valves in on to shaper or a miller and take a light skim over them, which will bring them down even. If the valves themselves are brass instead of rubber, they can then be faced individually each to its own seat.

There is another point to watch in regard to the seats. Sometimes the seats wear until they are just a little lower than the casting they are held in, and if the valve is the least bit larger than the seat in diameter, it is held up by the casting and, therefore, is kept open. This point should be carefully watched, as it not infrequently causes trouble, and is not always immediately obvious when looking for the cause.

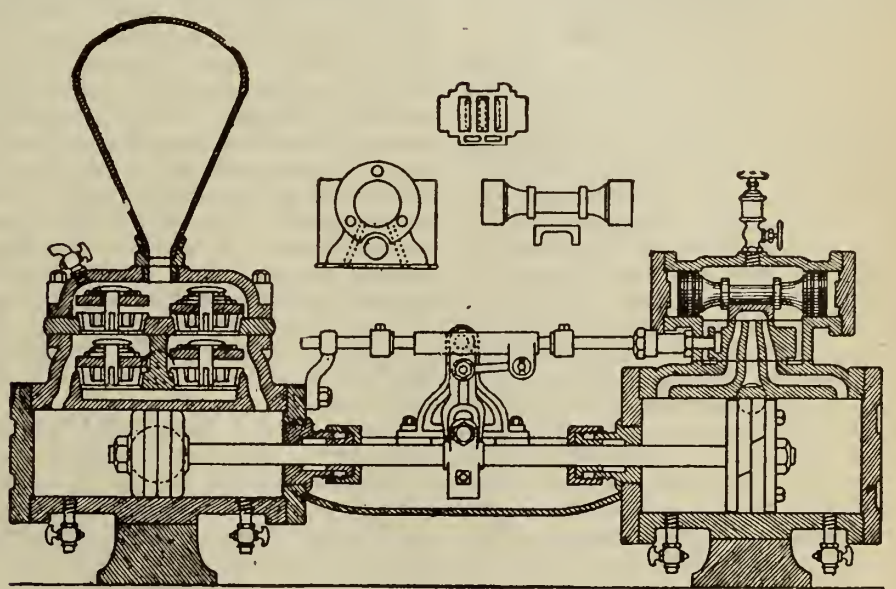
The Valve Seats.

Valve seats are usually screwed into the castings, on the duplex type of pump, and lugs are provided inside the seats to enable them to be screwed out with a special wrench. The threads are usually tapered like a pipe thread, and it is usually a matter of great difficulty to get them started if it is wished to take them out. In some cases valve seats are driven in to the casting and in these cases it is sometimes the practice to fit a set screw to prevent them working loose. It is easy to remove this type of seat by simply placing a plate across the bottom of the seat, and pasing a bolt through to the top passing through a plate laid over the opening. The nut is then screwed down on the top plate, pulling the bottom plate and seat up with it.

The only time it is necessary to remove a screwed seat is when it gets so badly worn that it is not possible to do any more with it. It is not going to be used again, and the quickest and best way to remove it is to take a fine cross cut chisel and split down one side of the seat, after which it can be easily turned out. If it is desired to save it for any reason it will not do to use this method, but it has been my experience that when a seat of this type is removed there is no intention of putting it back and it saves time to cut it rather than try and turn it out. Of course, care must be taken that the chisel does not damage the thread of the casting or it will be difficult to make the new seat a tight fit. A little care will ensure this does not happen. When putting the new seat in, it should be made a good fit all the way in, and not slack two-thirds of the way and tightened up at the last. If you do not have spare seats on hand from the makers of the pumps, or they cannot supply them, let the machinist who is going to make the seats get his size from the casting, so that he can make a good fit.

It is not very often that new seats are required under ordinary circumstances, so that when they do have to be fitted, fit them so that they will last at least as long as the original ones.

(To be continued.)



SECTIONAL ELEVATION OF TYPICAL PUMP.

BULLETIN

The Yarnall-Waring Co., Philadelphia, have issued a new bulletin, No. R-1401, describing their Yarway Balanced Control Valve. This valve has been designed in the first place for use with the Yarway Lea V Notch Recording Meter which was described in these pages recently. The valve is of the double disc and seat construction, the valves being guided by wings. Renewable discs and seats are fitted. The operation is controlled by a float and lever.

Using Pulverised Coal in Central Station

Extract From a Paper Read by John Anderson, Chief Engineer of Power Plants Milwaukee Electric Railway and Light Co. and Dealing With Experience at The Oneida Street Station, Milwaukee

COAL in finely ground or pulverized form was first used successfully twenty-five or thirty years ago in the manufacture of cement. In this application its economy was quickly recognized and to the advantages it possesses in burning cement may be attributed the present high state of development to which equipment for pulverizing coal has already been brought. From this beginning its uses have broadened until now pulverized fuel serves to heat furnaces in numerous and diversified industries. Up to within a few years ago its use was most advantageous in those furnaces that operate under a slight pressure for the purpose of excluding air when the doors are opened and wherein a low velocity of gas travel is desired—typical requirements of furnaces in the cement, copper, and iron industries. For these special and for similar reasons, pulverized fuel found its greatest use in annealing and forging furnaces; in cement and lime kilns; in the manufacture of refractories and substances that require drying or burning; and in surface treatment of many metals.

However, with the recent heavy increases in price of coal any process which promised greater efficiency found a broad field opened up before it for application to stationary boilers. Previous to this time some work had been done in developing its use in locomotives, but the reasons for its application to stationary boiler furnaces, and the small saving that might be effected with coal at a low price did not promise to offset the cost of pulverization. Such conditions did not encourage the use of fuel in powdered form therefore until the higher prices of the last three years forced economy in every direction.

It is the purpose of this article to describe the pulverized coal fired furnace only as applied to the steam boiler excluding locomotive practice, to point out its advantages in such use and to state the economies effected thereby.

Pulverising

The use of pulverized fuel in any industry necessitates a special plant for preparing the coal. It is the cost of installing and operating this plant which will always determine the advisability of adopting powdered coal for steam generation in any one location. In such a plant there must be equipment to separate trampiron from the coal, to crush it to a size suitable for drying and feeding to the pulverizers, to remove the moisture and to finally grind it to the desired fineness.

As the coal is received at the plant in the form it left the mines, it is necessary to pass it over a magnetic separator which removes all trampiron, such as bolts, nuts, pick-points, etc., thus seving as a safeguard against damage to the pulverizing and conveying machinery. A crusher must be used to reduce the green coal to a size suitable for proper drying and pulverizing, unless coal can be procured in sizes less than ½-inch screening without sacrificing heat value which is usually at its lowest in smallest size screenings.

The fuel is next dried. The object in drying the coal is to bring it to a condition in which it can most easily be pulverized and most uniformly controlled by feeders into furnaces. In a pulverized coal fired furnace, most uniform temperature conditions are obtained with dry coal. Moisture in varying or large quantities in pulverized fuel definitely prevents a regular controllable flow of mixed fuel and air to the burners. For the removal of moisture a mechanical dryer, which reduces the water content of the fuel to about one or two per cent., is installed. This dryer usually consists of a double rotating cylinder, so arranged that hot gases from a small furnace are passed through the coal as it travels by gravity through the shell of the dryer and is delivered to the pulverizers.

The dried coal is next fed into the pulverizers. The fuel is ground to an impalpable powder, varying in fineness from 80 per cent. to 85 per cent. through a 200-mesh screen. This process completes the preparation cycle and the coal in this form, after being conveyed to storage bunkers adjacent to furnaces, is ready for firing.

Dust Collecting

Dust collecting and reclaiming equipment, although only auxiliary to the drying and pulverizing machinery, is of great importance in the most economical, as well as the cleanest operation of a preparation plant.

The cost per ton of preparing coal depends upon the size of the plant and the quantity of fuel handled, but ordinarily will vary between the limits of twenty-five and fifty cents. It seems that a great deal of work toward reducing this cost remains to be done, especially along lines of utilizing waste gases for drying, in plants not provided with economizers. Development of a furnace design which will allow of burning a large percentage of finely divided coal, but capable of taking care of a smaller amount of larger sized particles, presents further study along this line. This is possible in view of the fact that the pulverizers consume about 86 per cent. of the total electric energy required for all moving parts of the coal preparation equipment. Both of the items mentioned above, if capable of being reduced as suggested, will also cause a reduction in the cost of the pulverizing department labor.

Continuous and uniform operation of the pulverizing division of a plant is dependent largely upon the ability of the operators to recognize and meet the varying properties of the coal as it arrives. Dryer operation especially must be changed frequently so as to handle varying sizes of coal (from high percentages of dust to high percentages of small nut) and varying amounts of moisture, both inherent and surface, and yet supply continuously a coal of uniformly low moisture. Irregularities in the drying process usually manifest themselves throughout the entire coal cycle, and very often with the result that the fuel feeding system becomes plugged at points most readily affected by wet coal.

Little need be said concerning the equipment which feeds the fuel to the furnaces. Feeder screws (*1) driven by variable speed motors carry the fuel from the storage bins to the air mixing chambers from which it is blown as a mixture through pipes to the burners and then into the furnaces. Air additional to that used for carrying the fuel into the furnace is taken through auxiliary inlets, located in the furnace front, and can be varied in amount by manipulation of the stack damper, which serves to change the gas velocities through the boiler and thus the volume taken into the furnace. With coal and air supplies easily adjustable, perfect fire control is assured and it becomes at once obvious why coal is burned so efficiently in pulverized form.

Combustion Conditions

In further explanation of this it is well to consider briefly the indications of efficient combustion applied to the steam boiler. Chief among these is the percentage of carbon dioxide, or CO_2—the product of complete combustion—which is found in flue gases. Next in importance is the percentage of carbon monoxide, CO—a product of incomplete combustion—which may be found at the same time.

*1 Note—The feeder motor controls at the Oneida Street Plant are all provided with cutout and if at any time the air blast to the mixing chambers and burners is lost due to a blower shut down all coal feeders are automatically stopped thereby preventing serious plugging with attendant interruption to operation of boilers for what could easily be a considerable period.

The condition desirable is that with the percentage of CO_2 as high as practicable there should be no CO—a condition obtainable to a greater degree in a pulverized fuel furnace than in any other type. Complete combustion with the least amount of excess air requires the best distribution of that air and the problem of furnace efficiency therefore resolves itself mainly into one of air supply, not to the furnace alone, but to each particle of coal. With a fuel finely pulverized, air can be made at once available to each particle since the surface exposed to air is increased many times that of a lump and combustion is rapid, complete and efficient. With fuel in lump form air must be supplied through a bed, the outer surface of the lumps must be burned off, the process of combustion eating into the lumps slowly and as a result combustion is often gradual and unequal—where the fire is thin too much air is passed; where it is heavy there is too little air. To insure complete combustion in any furnace some excess air must therefore be provided. The use of pulverized fuel reduces this excess to a minimum, gives a higher and more uniform percentage of CO_2 and therefore a higher and more uniform efficiency.

The percentage of CO_2 to be maintained in pulverized fuel practice is determined to a great degree by furnace limitations rather than combustion consideration. From 16 to 17 per cent. CO_2 in the flue gases is easily obtainable but it cannot be maintained in actual operation due to exceedingly high flame temperatures that result and the consequent destruction of the brick work. The temperature of the furnace therefore must be regulated by varying the volume of excess air. The temperature of the flame should not be above 3,000 degrees F. and that of the brick work in the flame zone not more than 2,400 or 2,500 degrees F. Higher temperatures than these usually result in fusion of the ash particles and formation of a molten slag which is very destructive to the brick work with which it comes in contact.

In attempting to carry combustion conditions of a furnace so as to obtain exceedingly high percentages of CO_2 usually too little attention is given to the losses resulting from the formation of carbon monoxide or CO. Carbon monoxide, a highly combustible gas, is formed when the excess air admitted to the furnace is insufficient to properly surround and completely oxidize all the coal particles. Heat losses occurring when carbon monoxide is present in the gases of combustion, outweigh any gains that may be effected by an exceedingly high CO_2 and are always to be avoided.

Wide Variations of Quality

In the discussion of furnace efficiencies consideration should be given to the adaptability of a pulverized fuel fired furnace to the use of widely varying grades of coal without resultant losses in economy. Further, boiler capacity, even under heavy overloads, is in no way affected when an inferior quality of coal is burned. It is known that the combined efficiency of a boiler and furnace does not decrease when the fuel is poor, which condition does not hold true for the stoker. In the case of the stoker, the dropping off in efficiency is at a more rapid rate than the B.t.u. value of the fuel would indicate as normal, and so much so, that the point is rapidly reached when proper combustion cannot be maintained.

Operation of a pulverized fuel fired boiler, equipped with proper instruments, can be varied to take big fluctuations in load over very brief periods of time. A heavy overload can be quickly taken on or dropped off by adjustment of the coal and air feeds, and without any waste of fuel as always occurs under like conditions in stoker practice. No losses occur due to clinkering of coal or cleaning of fires, this condition of operation being entirely eliminated. Irregularities caused by change in quality and variation in size of coal, such as the fireman cannot successfully cope with on stokers, are also eliminated. Furnace conditions necessary to most economical combustion are more perfectly obtained and hence a horizontal combined efficiency curve is possible of approximate attainment.

Due to its easily regulated coal and air supply and its perfectly controlled rate of combustion, the pulverized fuel furnace practically eliminates losses of combustible in ash. Ordinarily this loss is relatively large and varies according to the nature of the coal, type of stoker and the boiler load carried. In pulverized fuel practice the loss is very small and these variations do not occur.

The ease with which the fuel feed and draft is controlled, the ability to take on and drop off heavy overloads in a brief time, the thorough combustion of the coal and the uniformly high efficiency obtainable under normal operation constitute the chief advantages of pulverized fuel over other methods of coal burning.

An additional economy is effected during banked boiler hours. Banking conditions when operating with pulverized fuel are somewhat different than those obtained in stoker practice. By stopping the fuel supply and closing up all dampers and auxiliary air inlets, a boiler fitted for use of pulverized fuel can be held up to pressure for several hours. The furnace brick work having been heated to incandescence during operation gives off a radiant heat which is almost all absorbed by the boiler rather than escaping up the stack intermixed with an excess of cooling air. Radiation losses only occur as against radiation plus stack and grate losses in the case of the stoker.

Maintenance Features

Commenting for a moment on the maintenance features of such a plant as has been described it is the writer's belief, based on two years' operating experience, that the furnace brick work in a pulverized fuel furnace will stand up equally as well as a stoker installation, with a very great advantage in favor of the former due to the elimination of all iron work in the furnace or anywhere near the high temperature zones of the boiler furnace. Regarding the maintenance of the pulverizing plant equipment it has not been found that any great amount of maintenance is likely to be necessary as all the equipment is of the slow moving type and many opportunities are afforded of applying the same concentration of effort that has been typical of the stationary engineer's work in improving equipment when defects or fast wearing parts are uncovered. The pulverized machinery manufacturers have done a great deal along this line, but there are still matters that can be improved upon by the engineer looking for the least troublesome as well as most economical plant from a maintenance standpoint.

Powdered fuel installations are not feasible in every location. There is one limitation and that is the size of boiler plant to be served. A plant of less than 2,500 developed boiler horsepower on a twenty-four-hour operating basis should not consider using powdered fuel. The amount of coal pulverized per day, the cost of installation, and the labor for operating preparation plant, when properly studied, will bring before those interested the reasons therefor.

In general, we have found the powdered fuel method applied to our furnaces a distinctly advantageous one. Our firemen prefer to operate such equipment rather than the stokers when it becomes a matter of choice. It has proved more economical as evidenced by the monthly coal bill. It seems to make the formation of scale in the boiler less than in stoker fired boilers. There is absolutely no trouble from smoke, consequently no reduction in ability of boiler to absorb heat due to soot on tubes.

The use of high sulphur coal which is so destructive to boiler tubes, breechings, smoke stack, and all other steel equipment found in a boiler plant is much more satisfactory as the low moisture content of coal as fired reduces the opportunity for attack from sulphuric acid.

Danger of Explosion

Although frequently cautioned against explosions, we have had no evidence that such caution is necessary. The reason for our freedom from such unpleasant occurrences is due almost entirely to a proper care in preventing coal from being dried too much and pulverized to a fineness beyond what is necessary. Matters of a kind similar to the fore-

(Continued on page 33)

Hazards from Coal Dust in Industrial Plants

Tests of Explosions—Fires in Storage and Bins—Some Suggestions—Danger From Backfires—Results of the Investigation by the U. S. Bureau of Mines

SINCE the introduction of pulverized coal as a substitute fuel for natural gas in various types of heating furnaces used in steel mills, a number of fires and explosions have occurred, resulting in the loss of life and property.

As one of the primary functions of the Bureau of Mines is to conduct investigations in the utilization of mineral substances with a view to increasing safety in the use thereof, it was deemed advisable to investigate the hazards involved in the industrial use of pulverized coal and, if possible, to devise methods of preventing future accidents arising therefrom. The knowledge of the explosive qualities of coal dust which the Bureau has gained in studies affecting dust explosions in coal mines was of material assistance in these investigations.

Several plants were visited in which either fires or explosions had occurred, and data obtained as to the probable cause of the accidents.

There was found to exist, among some of those employed about the furnaces, a lack of knowledge of the explosive and inflammable qualities of powdered coal.

A small stream of pulverized coal leaking down from a defective joint in a coal transport line did not attract much attention, whereas, had a leak in a natural gas line occurred under similar circumstances, no doubt it would have had immediate attention.

As a matter of fact, if by any means the dust cloud should come in contact with an open flame or hot metal, the effects would be as disastrous as if it had been gas.

This is exceedingly well illustrated by an accident which came to the writer's attention. In the system used at this particular plant, the pulverized coal is transported to the furnace through compressed-air lines. The fuel is fed from a storage bin to a blowing tank in quantities as desired, after which compressed air is admitted and the powdered coal blown to the furnaces. At the time of the accident some repairs were being made to the tank, and it was supposed that the air pressure had been entirely released as the pressure gauge stood at zero. There was, however, one or two pounds air pressure remaining and when one of the connections was taken off, a cloud of dust was blown across the room, 30 or 40 feet, towards the drier furnace where it came in contact with some live coals. Immediately the entire room was filled with flame which rolled back and forth over a space 60 feet or so in length.

It would seem desirable, as regards safety, if the management of all industrial plants in which pulverized coal is used for fuel, and especially of those plants in which heating and annealing furnaces are installed, would impress upon their employees the fact that clouds of fine coal dust are as dangerous as a body of unconfined natural gas, if the dust is liberated in close proximity to an open flame or mass of red-hot material.

Tests of Explosions

In the tests made of coal-dust explosions in the experimental mine of the Bureau of Mines, pressures as high as 130 pounds per square inch have been recorded, such high pressures are however, obtained only when the explosion has traversed some distance through the confined passageways of the mine. A somewhat analogous condition might be noted in an instance which came under the writer's observation. Coal dust was undoubtedly ignited in a pulverized-coal transport-line of spiral riveted pipe quite some distance from the fan furnishing the propelling air current. The pipe line confined the explosion until it reached the fan, when the cast-iron casing was completely shattered. Experiments have also demonstrated the fact that a mixture of 30 per cent. pulverized coal dust and 70 per cent. of finely powdered shale is explosive. These tests are applicable to the conditions that may be found in industrial plants, as they serve to show that the coal dust which may have settled on the floors and girders of the building is not necessarily rendered inert by the incombustible matter with which it may have become mixed.

Analysis of dust collected from the interior of mill buildings in which are situated furnaces using pulverized coal have shown that the dust sometimes contains as high as 23½ per cent. of volatile matter, only a little lower than pure Pittsburgh coal.

Fires in Storage and Bins

One of the most serious troubles with which users of pulverized coal have had to contend has been the number of fires in the storage bins for pulverized coal. It has been somewhat difficult to determine the exact cause of these fires, but undoubtedly spontaneous combusion has played an important part in the origin of some of them.

It is obvious that coal when finely powdered presents a much larger surface and a much larger quantity of coal to contact with oxygen than when in solid masses.

In tests by Parr and Kresssman ("The Spontaneous Combustion of Coal" by S. W. Parr and F. W. Kressman, Univ. Ill., Bull. 46, p. 71) it was learned that "The rate of absorption of oxygen increases so greatly with the rise of temperature that the warming of coal by a steam pipe or boiler may enormously shorten the time necessary for spontaneous combustion or render spontaneous combustion possible in cases where it would other wise be impossible."

Experiments by Porter and Ralston of the Bureau of Mines ("A Study of the Oxidation of Coal" by H. C. Porter and O. C. Ralston, Bureau of Mines Tech. Paper, 65, p. 13) have also determined that the rate of oxidation of coal increases rapidly as the temperature increases.

The attached chart shows the rate of oxidation of Illinois coal (ground to the fineness of 80 to 100 mesh) at different temperatures. It will be noted that at a temperature of about 150° F. the rate of oxidation is very rapid.

In experiments by Threllfall ("The Spontaneous Heating of Coal" by Richard Threllfall, Jour. Soc. Chem. Ind., vol. 28, pp. 759-773) in England on the spontaneous heating of coal, the point at which the temperature of the coal began to rise very rapidly was found to be about 150° F.

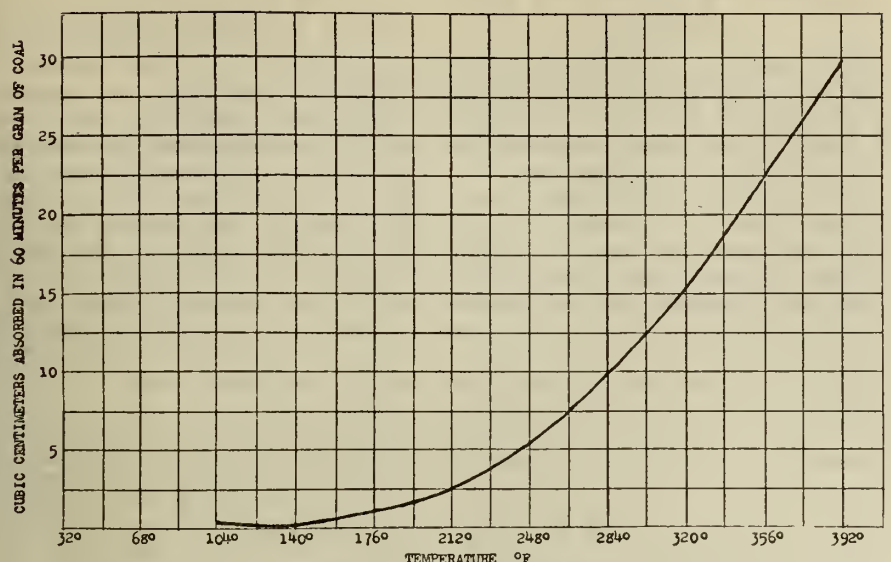
As the amount of heat generated in coal is in proportion to the amount of oxygen absorbed, from the above-mentioned expriments it is reasonable to assume that if enough air is present pulverized coal when delivered to a storage bin at a fairly high temperature, will in a short time approach the point of ignition.

In some of the systems used in drying and pulverizing coal, the fine coal, about 90 per cent. of which will pass through a 100-mesh screen and 70 per cent. through a 200-mesh screen, is delivered to the storage bins at a temperature of 125° to 130° F. It is possible, however, for the person running the drier to permit the fire to become hotter than normal and thus overheat the coal in the drier. Such an instance has been brought to the attention of the Bureau. In this case a pyrometer placed in the end of the drier normally registered a temperature of 150° F., but at the time of the explosion in the pulverizing house, a temperature of 350° F. was registered.

Where the drier becomes overheated, the coal may be delivered to the storage bins at a temperature at or above 150° F. If left in the bin for a comparatively short time, it is very probable that the temperature of the coal will rise to such a point that when mixed with air the coal will burn rapidly.

Overheating of the coal is especially liable to happen in the type of drier commonly known as "direct heat" drier, in which the gases from the combustion chamber pass directly through the center of the drum and come in contact with the coal passing through. Particularly

FIGURE 1.-- CHART SHOWING RATE OF OXIDATION OF ILLINOIS COAL AT DIFFERENT TEMPERATURES.



GRAPHIC CURVE OF ABSORPTION.

is this true if for any reason the drier should stop running, while at the same time the fire on the grates is permitted to continue burning.

Some Suggestions

In connection with the above-mentioned hazards, the following suggestions may not seem out of place. Care should be taken that pulverized coal is not delivered to storage bins at a high temperature; and to avoid this the gases of combustion from the drier furnace should not be allowed to become hot enough to overheat the coal. In "direct heat" driers, the fire should be so maintained that red-hot cinders will not drop into the screw conveyor feeding the pulverizer. The entire safety of the pulverizing plant largely depends upon the man tending the fire in the drier. If he is careless and builds a big fire on the grate, the chances for overheating the coal in the drier are very great. Or, if he should stop the operation of the drier and at the same time maintain a hot fire, hot coal will result, which might be carried into the pulverizer. Such carelessness would probably result in a disastrous explosion.

Storage bins for pulverized coal should not be placed in any position where they may become heated from furnaces, steam pipes or hot flues.

If a plant has been shut down for several days, delivery of coal from the storage bins through transport lines to the place of consumption should not be permitted before an examination is made to ascertain whether the coal has become heated to such a point that it will ignite when brought in contact with a current or blast of air. This can be done by pushing iron rods into the interior of the stored coal and leaving them there for a short time. When they are withdrawn, the temperature of the rods will indicate whether or not there is any fire or overheating in the bin.

It is believed that the spontaneous combustion of the coal in the storage bin is partly responsible for some of the fires that have occurred in the transport lines which convey the pulverized coal from either the main pulverizing plant or a substation to the furnaces.

A number of cases have been investigated by the bureau in which almost without warning flames burst from the coal lines, when apparently everything had been running smoothly; no stoppage in the lines or in the burners having been observed. However, on several occasions fires had been discovered in the pulverized coal storage bins.

It seems perfectly reasonable to suppose that the coal in the bins had become heated by spontaneous combustion to almost the ignition point and, when this heated coal was conveyed to the transport line, the air from the fan producing the circulating current supplied enough additional oxygen to produce incandescence which in turn, ignited the dust cloud passing through the line. The reason that an explosion did not immediately take place is not definitely known, but is attributed to the excess of coal dust in the line over the amount of air present. In fact, in one instance an explosion, which wrecked the line, did occur at a point just beyond a feed line to the furnace where there was a much leaner mixture of air and dust than at the point where the line was simply burned out.

That an exceedingly dense cloud of coal dust may come in contact with a flame and not ignite had been demonstrated in the laboratories of the bureau. A cloud formed by two ounces of pulverized coal and one cubic foot of air was suddenly brought in contact with a ball of burning oil-soaked waste and a lighted candle, with the result that the flames in the waste and the flame of the candle were both extinguished. In superdusting experiments carried on at the experimental mine of the bureau by George S. Rice, it was observed that a dense cloud of coal dust on coming in contact with a flame at the point of ignition blanketed the flame. However, if the same dust cloud were raised at a point where only a part of the cloud came in contact with the flame, there is a possibility that an explosion would occur. In other words, the pace of an explosion depends upon the quantity of the explosive dust upon which it can feed above the maximum quantity needed for propagation.

From the above-mentioned tests it would seem to be reasonable to assume that whether an explosion takes place or whether the powdered coal in the line burns without violence when red-hot particles are introduced into the pipe lines depends largely upon the density of the dust cloud at that particular time.

Danger From Back-Fire

Some of the fires that have occurred in the powdered coal distribution lines in several plants have undoubtedly originated from "back fires" from the heating furnaces. These, unquestionably, may be caused by the air pressures in the distribution line suddenly dropping below the secondary air pressures. By secondary air is meant the additional air supply, provided by blowers or otherwise, to furnish sufficient oxygen for proper combustion in the furnaces.

The drop in pressure is due to several causes—the fan that furnishes the air current for transporting the coal may be suddenly stopped; the air current may be interrupted by an obstruction in the transport line; or the opening in the burner may become partly closed by small particles of coal coking and adhering to the burner.

The back pressure thus created would tend to draw the heat from the furnace into the feed line, igniting the pulverized coal, and the fire would quickly spread to the distribution line. It may happen, if the primary air is shut off, that there will not be enough oxygen in the line to support combustion until after the air current becomes normal, when the smouldering coal may be fanned into flames.

It is of extreme importance to see that no opportunity is given burning particles to get into the transport line, either from the storage bin or by a "back fire" from the furnace.

Frequent inspection should be made of the burners and any coked particles thereon should be immediately removed.

As often as practicable, at night when the plant closes down if possible, all furnaces should be cut off the supply line, the gate from the pulverized fuel bin closed and the transport line thoroughly cleaned by allowing the fan to force a current of air through it until all the pulverized coal is blown out.

Where furnaces are equipped with individual fuel bins and the coal is delivered into the primary air line by means of screw conveyors, the fuel bins should be placed away from the furnaces. Several fatal accidents have been caused by dust overflowing the line, falling down in front of the furnace door, igniting and flashing up and enveloping the furnace operator in flames. It is true that bins may be fitted with automatic gauges and also completely covered, but even

with these precautions, dust clouds may be formed. Some of the steel companies, in whose plants accidents from overflowing bins have occurred, have placed every pulverized coal bin in the rear of the furnace and just outside the main building. By doing this all danger of a dust cloud coming in contact with hot metal or the flames in the furnace is reduced to a minimum.

In nearly every coal pulverizing plant, there is more or less fine coal dust deposited on the floor, the pulverizing machinery, girders and window sills of the building. If, for any reason, this dust should be raised into a cloud and then come in contact with an open flame, it is probable that an explosion would occur which would wreck the plant.

In fact there was an actual occurrence of this nature in a coal pulverizing plant in which a primary explosion happened in the pulverizer and raised the dust in the building into a cloud, ignited it, and the resulting explosion caused considerable damage to the building, as well as costing loss of life.

Every effort should be made to prevent any accumulation of dust in the building that houses the pulverizer. Certain manufacturing plants in which explosive dust is prevalent have installed vacuum cleaners to keep the buildings free from dangerous quantities of explosive dusts, and such systems have been in use for many years in Northen France and Germany in connection with coal screening plants. This would not be impracticable in a coal pulverizing plant. The recovered dust could be delivered to the pulverized coal bin and used in the furnaces.

It is unwise to depend entirely upon any system of ventilation to overcome the powdered coal dust hazard. It is practically impossible for the air currents produced by the ventilating apparatus to penetrate the angles and corners of the building, where the dust is liable to settle.

In examining storage bins and other places where coal dust may exist an electric light should be used for illuminating purposes instead of an open light. As a further precaution, the electric bulb should be protected by a wire guard to prevent breakage, as there is a possibility that a cloud of coal dust can be ignited by the red-hot carbon filament of an incandescent lamp. Care should be taken to see that the wire is properly insulated, so that an electric arc will not be caused.

To obtain the best results, as regards safety, in the use of pulverized coal as a fuel in industrial plants, it is important that both officials and men be educated to the idea that coal dust is explosive and therefore dangerous; and that under certain conditions it will ignite as readily as gas. This fact is not thoroughly understood and sometimes, only at the cost of life and property is brought home to those connected with the operation.—U. S. Bureau of Mines, Reports of Investigations.

DIFFICULT AND IMPOSSIBLE BELT DRIVES

The following little talk on belt drives is taken from the current issue of "Belts," issued by the Federal Engineering Co., Ltd. It contains some interesting points on belt driving, which will be useful to the power plant engineer:

"Some months ago we invited correspondence from our friends on belt drives with which they were having difficulties. We had a great many letters on this subject and are very much gratified with the interest taken in the matter.

"These letters opened our eyes to a condition existing in many plants that was a great surprise to us. We quite frequently are being asked our opinion as to a belt for a certain purpose, and find the pulley sizes, speeds, etc., make belting conditions practically impossible. We were not, however, prepared for the large number of examples of practically impossible drives that were offered us. The evidence shows such a frequent occurrence of this condition that we thought it would make a very welcome article to offer in this booklet.

"Belting men generally know that the width, weight, flexibility and thickness of the belt are governed by the pulley sizes, the pulley speeds and the horsepower to be delivered. Of course, there are other conditions, such as heat, moisture, etc., that determine the material from which the belt is made, but it is not the purpose of this article to go into the material.

"One of the first problems brought to the writer's attention was a compressor drive in which the belt cracked across the width after being in service for about one year. When a belt cracks across the width it is found in nine cases out of ten that it is due to slipping. On checking up the figures, a twelve-inch double belt was being used for driving a compressor.

"Diam. om motor pulley, 13 in.; r.p.m., 760; diam. of compressor pulley, 4 feet; h.p. of motor, 75.

"On compressor drives, owing to their intermittent nature, we have found that it pays to figure on a belt designed 40 per cent. heavier than for a normal drive. The belt speed of the above drive is approximately 2,600 feet per minute. Now a double 12 in. belt at this belt speed is theoretically good for about 90 h.p., and a belt is needed that will deliver about 106 h.p. This means that the pulleys on the compressor and motor should have faces wide enough to use a 14 in. double belt. This is what solved the difficulty and there is no further trouble.

"Operators of plants often do not know, or frequently forget, that a compressor drive being an intermittent load requires a belt that will deliver considerably more than the rated horse-power of the machine. Our experience has proven to us that a margin of 40 per cent. should be allowed. In this case there was no chance to put on a wider belt, as the pulley width was only 13 in., and this was limited by the position of the machine. A wider pulley could not be put on without changing the layout of the plant. In this case, as the owners considered the latter suggestion impracticable, the only thing that could be done was to put on another 12 inch double belt, keep it well dressed and occasionally apply an adhesive to keep the belt from slipping. This method would possibly give them about 2½ times the life of the belt which they had previously used. This condition, from a belting standpoint, is not good nor economical. It is a makeshift, and many such conditions in one plant would be a serious handicap.

"We do not know why it is, but we find that the manufacturers of compressors generally put the smallest pulley on their product that it will theoretically stand. We have found more trouble from compressor drives for this reason than on any other class of machine.

"In most cases where belts are not standing up we find that by changing the diameters of pulleys or widths of belting makes all the difference in the world between a satisfactory and unsatisfactory drive.

"When our salesmen are endeavoring to introduce our material into a new plant we are generally invited to try our product on the hardest drive. Now, we do not have to experiment. We can tell by a simple process of calculation just what the belt will do. The writer thinks that the many belting houses allow their salesmen to experiment with difficult drives. The house selling the belting generally does so at its own expense, which is proper; but in case of failure the customer loses faith in the product, when the whole trouble may be the result of factory conditions. We were offered a chance to try out one of our belts on a machine where four other firms had failed, one after the other. The drive was impossible. The diameter of the smaller pulley was too small to allow the use of the proper weights of belting, and the faces of the pulleys were too narrow to use a proper width. By changing the pulleys, keeping the proportions as they were before, so that the machine speed remained the same, the problem was solved, and there was no further belt trouble. The man who tried other belting before knew the drive appeared impossible, but the agent wanted to take a chance, hoping that it might stand up. In this case they failed to make a permanent and profitable customer, besides losing the value of the material.

"'We occasionally meet with a vertical drive in which the driver is directly over or under the driving pulley; that is where the belt is perpendicular. It is, of course, not necessary to comment to any extent on this, as all mechanical men know the probable result. The slightest stretch allows the belt to make slight contact with the bottom of the lower pulley, the result being excessive slip and loss of power."

The Relining of a 24 Inch Centrifugal Pump Shell

Use to Which Pump Was Subjected—Extent of Damage—Former Method of Repair—Latest Method of Building Up and Relining—Type of Equipment Used and Saving Effected

By J. H. MOORE

THE following article deals with electric welding and tells of an interesting repair job that is at present being performed by the Thompson Welding Co., Ltd., Toronto, Canada.

The work is that of building up the shell of a 24-inch centrifugal pump, which has been used for sucking up the sand from the Toronto bay. The two halves of this shell are shown in the photograph accompanying the article. Needless to state the sand, grit, and pebbles have worked havoc with the pump shell, which is a steel casting; until at the present time the interior is a mass of holes, grooves, and cavities. Before the pump is fit for use, these have to be filled up, and when we state that some of the grooves are 22 inches long, about 1 inch to 3 inches wide, and ranging from ½ inch to 2½ inches deep, readers can form some idea of the task ahead. Not only are they filling up the holes, but they are building up a ⅜-inch thick lining all around the inside of the shell.

So far, 600 pounds of metal has been used in the building up process, and at least another 150 pounds will be necessary before the work is completed. The small view to the right of the general photograph, depicts the operator busy at work. Some of the cavities can be noticed to the left of the workman, although the photograph cannot attempt to do justice to the number nor size of these grooves.

A Lincoln D.C. 150 ampere machine, mounted on a truck as shown in photograph is being used, and a total time of five weeks is expected to complete the work.

Previous to this particular job, the same company repaired a similar pump last year, although in that case they merely filled the holes up. In spite of this, the pump delivered 980,000 cubic yards after the repair, showing that the owners completed a fine stroke of business in allowing such repair to be effected.

In the present case, the saving will be over $4,000 as a steel casting of the huge size shown would run into quite an expense. On top of that there is the question of delay, so that in many ways the repair proposition is by far the better in this case.

Speaking of the company's activities, Mr. Thompson, the manager, stated that so far this year they had welded 35 boilers on boats at Midland and Port Nichol alone. These included all the C.P.R. passenger boats at these points.

He told of an interesting job performed on the tug Joseph E. Russell. The high pressure cast iron cylinder bottom gland was knocked out, so they proceeded to weld it in place, and made a splendid job of it in quick order. He told of many other jobs performed, but sufficient to state that they have completed various repairs on the great lakes transportation work, from January 1st right up to the 15th of April. They state they had as high as eight machines working at one time.

GENERAL VIEW OF THE OUTFIT AT WORK. A CLOSE UP OF THE OPERATOR.

PETERBOROUGH FILTRATION PLANT

In connection with the new filtration plant of the Peterborough Water Works we are informed that the contract for the two six million gallon centrifugal pumps has been awarded to Escher Wyss & Co., Montreal. This firm's works are located in Zurich, Switzerland. The motors and switchboard will be supplied by the General Electric Co.

HUGE OIL SCHEME

A British oil company is erecting a huge plant for the storage and refining of oil. A new village has been built in the neighborhood of the plant for the accommodation of the work people and staff connected with the enterprise. Between the plant and the port a pipe line has been constructed and the first cargo of oil was recently sent along the pipe. According to a figure received, the scheme will cost roughly $20,000,000.

USING PULVERISED COAL

(Continued from page 29)

going are in the hands of the operating engineers and do not benefit by high-brow application of theories. The engineer who is careful of his every-day equipment and keeps his plant free from accidents of every nature, from flywheel explosion to burned out motors, can operate a pulverized fuel plant successfully without other assistance than his own experience.

In the preceding paragraphs an endeavor has been made to describe briefly the equipment and method necessary to apply pulverized fuel to the steam boiler, and to point out the results to be expected from its use. The merits of powdered coal based on its efficiency and its flexibility to meet varying demands have been set forth and general facts concerning its operation stated.

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POWER HOUSE

MAY 20th, 1921

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Engineers in Refrigerating Plants

THERE is at present legislation being put through, if not already passed, requiring men employed in refrigeration plants entirely driven by electric power to obtain certificates similar to their confreres of the steam plant. Just what form this legislation will take we do not know at this time of writing, but we imagine the requirements will be modified to suit the job. It is only right that these men should have to pass a test showing their knowledge of the machinery they are handling, but at the same time it would hardly be fair to expect the same amount of engineering knowledge that would be required of a man who was going to take charge of a plant containing engines and boilers as well as the refrigerating machines, or even without refrigerating machines. The candidate for a first-class stationary engineer's license is expected to know the principles of refrigeration, something of the principles of electricity and the principles of steam, in addition to his practical experience. The position of the man in a refrigeration plant driven by electric power purchased from outside sources is more that of a watchkeeper or attendant than an engineer and the requirements of the position not of so high a standard as that required of the stationary engineer. Service in a plant of this kind should not count the same as service in a steam plant for the purpose of getting full stationary engineer's license, and while a stationary engineer with experience in refrigeration would be quite capable of taking charge of a purely refrigerating plant, a man whose experience was entirely in refrigeration would not be a fit man to assume charge of a combined steam and refrigeration outfit. It seems to us that this legislation will have to be very carefully drawn if it is not going to work a hardship on anyone. Until we have seen the proposed law of course we cannot presume to say what effect it is going to have, but trust that those concerned in having it passed have looked at every angle before going ahead.

Need for Uniform Laws

IN concluding an article on the engineer's licensing laws in Nova Scotia the author speaks of the probability of the passing of uniform boiler construction laws, and of the consequent probability of the passing of uniform engineers' license laws. These are consummations devoutly to be wished, but we have heard of them for so long without seeing any action that we are rather skeptical.

It is hard to understand why the condition where every province has a different law with reference to boiler construction and engineers' qualifications survives. No sane person can maintain that a boiler is safe in one province or unsafe in another or vice versa, or that an engineer who is competent to take charge of a plant of a certain size in Quebec is not competent to run a similar plant when he reaches some other province. Either a boiler is safe or it is not safe, and its geographical position has nothing to do with it, and a man is competent or incompetent whether he is at the North Pole or the South. The thing to do is to have a standard requirement which will enable a man to be certified competent in any part of Canada, and if he does not measure up to that standard to be incompetent in any part of Canada. We fear it will be a long time beore this condition is brought about.

Canada's division into nine provinces, each with its own government, and each to a certain extent independent of the others, militates very much against concerted action on the part of all the different governments. We think that matters like boiler construction and engineer's certificates should be in the hands of the Federal Government, but the Provincial Governments are of course very jealous of their rights, and will not allow the Federal Government to perform any function that they consider theirs by right. So we have in each province a different standard, and we have the condition that tends to make each province and each province's engineers isolated bodies.

We are aware that there are those among engineers themselves who are against it being made any easier for engineers to move from one province to another but we fail to see any good reason for it. What we should consider the most desirable thing of all would be for the various Dominions comprising the British Empire to get together and establish a qualification for marine engineers, so that a man who had obtained a certificate in any part of the Empire would be recognized as a competent engineer in any other part he might wish to go and work in. Air-tight compartments are not good for either men or nations, if they want to develop.

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Progress in New Equipment

THE CRAIG DAMPER REGULATOR

A new type of damper regulator is described below, the product of the Craig Damper Regulator Co., of Detroit, Mich., the Canadian agents for whom are the Underfeed Stoker Co. of Canada. The damper control is worked from the draft instead of by the steam pressure, and very close regulation is obtained. It is especially adapted for forced draught work, where it is very desirable to keep the furnace pressure just slightly above atmosphere, so that there is no infiltration of air through furnace doors and other openings.

Operation of the Damper

The drawing below shows the construction of the Craig regulator. It consists essentially of a bell float (A) provided with a water seal within a cylindrical chamber. The under-side of the bell communicates by a draft pipe (B) with the boiler furnace; so that the same draft is carried on the under-side of the bell as is carried in the furnace. The top of the bell is attached to the control valve (C) by a rod. The weight of the control valve and bell is counterbalanced by a small weight (D) which is connected to the valve (C) by means of a cord and a small sheave wheel. Small weights are added to give draft condition desired.

Friction Minimized

The control valve has a comparatively loose fit, and practically the only friction in the movement of control parts is that of the small sheave wheel, which is negligible. This explains the responsiveness, great sensitiveness and accuracy of Craig regulators.

Assuming that it is desired to carry a constant furnace draft of five hundredths of an inch of water a weight (D) corresponding to this draft is placed on the control valve counterbalance. This extra weight tends to raise the belt float, and the corresponding furnace draft of five hundredths of an inch is necessary to create a vacuum under the bell float to maintain equilibrium. In case the furnace draft increases there will be an increased vacuum under the float and it will be pulled down. This will also pull down the control valve, sealing off the valve control ports to the upper side of the piston chamber; the water pressure above the piston will be increased and the piston forced down below the control valve, when one of the ports will be opened and the water pressure released. The control valve has thus forced the piston down and closed the damper sufficiently so that the draft of five hundredths of an inch is again obtained in the furnace and also under the bell, and the float members and counterbalance weight are again balanced. If the furnace draft should decrease the reverse would occur; the vacuum under the bell would not be sufficient to hold it down against the counterbalancing weight and the bell would tend to rise raising the control valve. The water pressure above the piston would be released and it would rise and keep opening the damper until a furnace draft of five hundredths of an inch was again obtained.

Quick Opening

A very important feature of the regulator is the provision for quick opening of the damper. Each port is several times larger than the water inlet opening, so when the draft in the furnace decreases, raising the control valve, the piston rises rapidly, causing the damper to open quickly. This, of course, is highly desirable since it insures proper outlet for the gases when a sudden overload occurs.

Retarded Closing

The reverse is true when closing; the amount of water used being small, the piston will be forced down slowly, giving an easy closing of the damper. This is important in preventing a flattening action of the damper and creating a sudden furnace pressure which in many cases would endanger the fireman.

Since the volume of water supplied to the cylinder is controlled by a throttle valve on the water line, the speed of closing can be readily varied to suit the requirements of the individual installation.

Carrying different furnace drafts merely requires changing the small counterweight. Due to the large cross-sectional area of the bell float, a small change in draft creates a large unbalanced force. This readily overcomes any friction that might occur, and thereby maintains extremely close regulation.

As the amount of water used is very small, the throttle valve in the water line is only opened enough to obtain just sufficient pressure in the cylinder to operate the piston and damper. The pressure used in the cylinder being low, there is practically no wire drawing and wear on parts. This instrument has no springs or delicate parts to get out of adjustment. The bell chamber is connected to the boiler furnace by a pipe line and there is no possibility of damage to the instruments by pressure created in the furnace chamber.

Variations in water pressure do not affect the operation, and the regulation will work on any pressure from 15 pounds up.

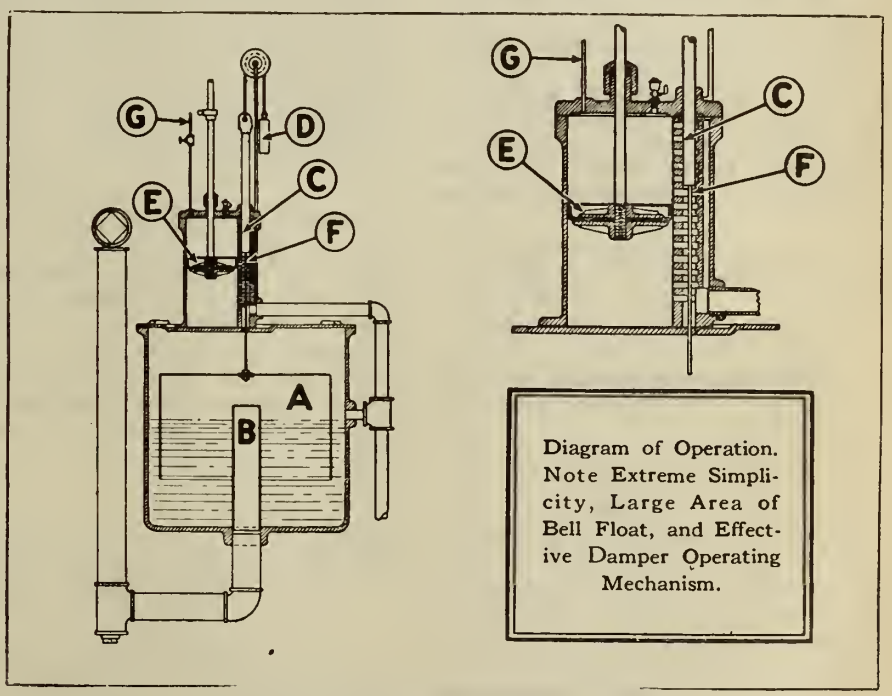


Diagram of Operation. Note Extreme Simplicity, Large Area of Bell Float, and Effective Damper Operating Mechanism.

SECTIONAL DIAGRAM OF CONTROLLER.

CHIMNEY DESIGN

By H. M. BRAYTON
Mechanical Engineer, Philadelphia

DRAFT of a chimney is due entirely to the fact that hot air has a lower density, that is, is lighter than cold air. The air inside of the chimney is heated to a high temperature by the hot gases from the furnace. This column of hot air within the chimney weighs a certain amount in actual pounds which is decidedly less than a similar column of outside air. This difference in weight between these two columns is what makes the draft. The draft as measured in inches of water is actually the difference between these weights less the small amount of loss due to the friction of the moving gases against the side walls of the chimney. This draft will be a maximum at the base of the chimney and gradually become less as we move back toward the ash pit.

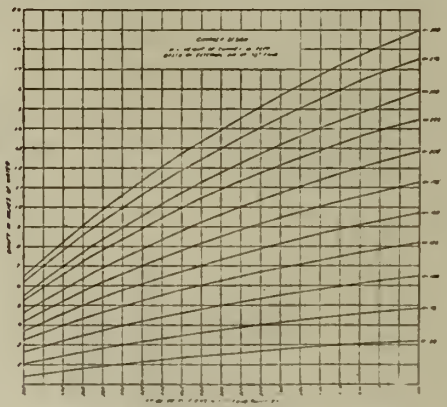
The column of hot gases within the chimney is not of uniform temperature but decreases as we go toward the top. This fact makes calculation on the draft difficult. Until recently it was assumed that the temperature varied from the base to the top uniformly. This theory has proven false by researches conducted back in 1911 on the L Street Station of the Boston Edison Company at Boston. These investigations were carried out by two senior students at the Massachusetts Institute of Technology. From the results of a large number of readings of the temperature at various heights from the ground they were able to plot a temperature height curve. This curve was found to be decidedly not a straight line.

An equation was fitted to this curve of the form in which $n = 25\ H\ Tn = K$.

H = height of any point in chimney above center of flue in feet.
T = Absolute temperature in deg. Fahr. (Temperature Fahr. plus 459.5).
K = A constant the value of which was found to be [75.4032]. (That is log. K = 75.4032.)

The next step was to get the average temperature by dividing the area under the curve by the height. By means of this formula, the specific volume of flue gas, specific volume of air and so forth, it was easy to calculate the draft available from different base temperatures. This calculation is somewhat complicated and will not be given here. The writer has, however, calculated it for the whole required field and incorporated the information in a graph shown in Fig. 1. The ordinate is draft in inches of water, while the abscissa is base temperature. This chart is based upon atmospheric air being at 70 deg. If the air temperature goes above this amount the available draft will be slightly less than that shown by the curves, while if the temperature is lower outside the draft will be more. These are not straight lines but irregular curves. Each point had to be carefully calculated. The various lines showing H from 50 to 300 ft. cover the practical field. Usually we know the base temperature and the draft desired and desire to know the height of chimney required to meet these conditions. Merely find the junction point of these horizontal and vertical lines and the nearest chimney height just above is the one to use. Suppose we have a base temperature of 540 deg. and desire a draft of 1.00 in. of water. The chart shows that we must build a 200 ft. chimney to give these results.

This chart gives a lower draft than most formulae designed for this purpose. Nearly all of the formulae in common use to-day are based on a constant temperature condition throughout the chimney which does not exist. This work was built on experiment and should be more accurate than one devised from theory alone. This formula shows that very little draft is gained by building the chimney above 200 feet. The added



DRAFT AND TEMPERATURE CHART.

cost of the foundation for these excessive heights is seldom justified by the added draft available.

Gebhardt gives a formula for determining the draft from a chimney. This formula, which is based upon the average temperature assumption, is as follows:

$$D = \frac{H}{7.64} - \frac{T_2}{7.95}$$

Where D = Draft in inches of water.
H = Height of chimney in ft.
T_1 = Temperature of outside air deg. absolute.
T_2 = Temperature of chimney gases in deg. absolute.

This formula gives much higher drafts than the previous formula. For a temperature of 540 deg. for the chimney gases and a 200 ft. chimney, as assumed in the other problem, we would here have not 1.00 in. of draft but 1.40 in.—a 40 per cent. increase. Actually, we would not get this. Is it not always better to err on the safe side? If we plan our chimney on this formula we are apt to find after it is all built that sufficient draft is not available to run the furnaces properly. This formula is out of date and in reality is seldom used by specialists in this branch of engineering. Years of practice have enabled them to design properly a chimney to meet practical needs.

Capacity of Chimneys

Chimneys must not only be able to give the required draft, but they must also be sufficiently large to carry away the volume of gases generated by the coal burned. This rate of combustion is always known and the interior area of the chimney made accordingly. The cross section area may be based upon the boiler horsepower connected to it or it may be based upon the grate area. Either method reaches the same result. Kent's formula, which is well known, follows:

$$\text{B. hp.} = 3.33\ E \sqrt{H}$$

Where B. hp. = Boiler hp. connected to the chimney.
E = Cross section area of interior of chimney in square feet.
H = Height of chimney in feet.

By transposing this equation we get the one more often used as follows:

$$E = 0.30 \frac{\text{B. hp.}}{\sqrt{H}}$$

Some engineers prefer to proportion their chimney area on the grate area. In practice it has been found that satisfactory results will be had if the interior area of the chimney is made one-tenth (0.10) the total grate area which it serves. If the plant is small, say not over two boilers, this ratio should be increased to one-eighth. This ratio depends to some extent on the height of stack. When the chimney is low, say not over 100 ft., the area should be made at least one-seventh the grate area.

Another formula for determining height of chimney, which is very simple to use, should also be mentioned here.

Where H = Height of chimney in feet.
d = Draft in inches of water.
K = A constant which varies with the base temperatures = 0.007.

This equation gives more nearly the true results. It shows that a draft of 1.00 in. of water requires about a 180-ft. chimney.—Southern Engineer.

HELPING THE OLD-TIMES

The spirit in which British industrial concerns interpret their duty to their employees is exemplified by the action taken by two of the leading railway companies in connection with superannuation allowances for old servants. Owing to the change in the value of currency since the war the original allowance had become inadequate and the companies voluntarily decided to increase the allowances to superannuated servants and also to improve the scale of benefits for those servants entitled to superannuation. This action is all the more striking as the only fund at present available for such concessions is the dividend fund. The additional amounts, therefore, come out of the shareholders' pockets.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

CONDENSING AND NON-CONDENSING

Question:—When changing over from condensing to non-condensing is it necessary to alter the setting of the valves in a four-valve engine?

Answer:—Generally when changing from non-condensing running to condensing, as often occurs at the end of the winter season, when heating is no longer required, it is found necessary to make some alteration in the setting of the exhaust valves. This is accounted for by the difference in the terminal or exhaust pressure, and consequently the volume of steam remaining in the cylinder when compression takes place. When running non-condensing the pressure in the cylinder when compression begins is usually something above atmosphere, and the pressure rises by the end of the stroke to something near the initial pressure. When condensing the pressure in the cylinder will be only about 5 pounds absolute and, therefore, the compresssion pressure before the opening of steam will be considerably lower. In order to insure smooth working, therefore, it is necessary to make compression take place a little earlier, so that there is more steam to compress, and thus the pressure will be brought nearer to that obtained when working non-condensing.

* * *

BOILER HEATING SURFACE

Question:—Please tell me how to find heating surface of a H.R.T., 16 x 66, with 66 tubes 3½ inches diameter. What is the rule for finding diameter and weight of a flywheel for an engine 10 inches x 16 inches and the speed the engine is to run?

Answer:—The heating surface of the boiler may be found by taking the area of half the shell, and the area of the tubes on their outer surface. This will be found as follows. The shell being 66 inches diameter or 5.5 feet, the area will be:

$$\frac{5.5 \times 3.1416 \times 16}{2} = 138.23 \text{ sq. feet.}$$

The area of the tubes will be:

$$\frac{3.5 \times 3.1416 \times 16 \times 66}{12} = 967 \text{ sq. feet.}$$

and total heating surface is:

138.23 + 968 = 1,106.23 sq. feet

and with 15 square feet to a horsepower the rating would be 1106.23 ÷ 15 =73.75, roughly 74 h.p.

With regard to the weight of flywheel, this will depend on so many different factors that one cannot give an answer off-hand. The point of cutoff has a great deal to do with it, the horse-power to be developed, which again depends on steam pressure and engine speed. For an engine of the size you mention the piston speed will be from 500 to 600 feet per minute. That would be 250 revolutions, assuming it is a high speed engine. One of the most easily applied formula is that of J. B. Stanwood, which is as follows:

$$W = 700{,}000\ d^2 s \div D^2 R^2$$

in which W=weight in pounds, d=dia. of cylinder in inches, s=stroke in inches, D=Diameter of wheel in feet, R=Revolution per minute. The co-efficient may be varied as follows for slide valve engines, 350,000. For same electric lighting duty, 700,000. Automatic high speed engines, 1,000,000. Corliss engines ordinary duty 700,000, and electric lighting 1,000,000.

The average fly wheel radius is from 3 to 5 times the length of the crank, according to Rankine. This gives the figure for D approximately.

$$W = \frac{700{,}000\ d^2 s}{D^3 R^2}$$

$$= \frac{700{,}000 \times 10 \times 10 \times 16}{4 \times 4 \times 250 \times 250}$$

=1120 lbs.

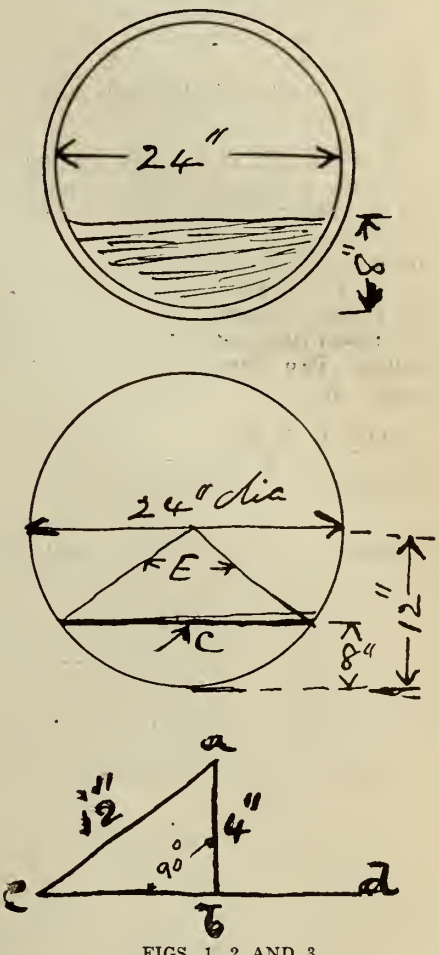
This formula is based on the assumption that the lowest piston speed will be 480 feet per minute.

* * *

CAPACITY OF TANK

Question.—How many gal. of oil does a circular tank 24 in. x 96 in. contain when the depth of the oil in the tank is 8 in., the tank being in horizontal position.

Answer.—First find the area of the cross-section of the oil. As there are many rules by which we can get the area of a segment of a circle approximately, a very convenient formula, often used by engineers, that does away with the necessity of applying the principles of trigonometry and which gives almost exactly the required area is given here as follows:



FIGS. 1, 2 AND 3.

$$a = \frac{4h^2}{3} \sqrt{\left(\frac{D}{h} - .608\right)}$$

In which a = area of segment.
h = height of segment.
D = Dia. of the circle of which the segment is a part.

Substituting

$$a = \frac{4 \times 8^2}{3} \sqrt{\left(\frac{24}{8} - .608\right)}$$

$$a = \frac{4 \times 64}{3} \sqrt{(3 - .608} = (85.33 \times 1.546) = 131.9 \text{ sq. in.}$$

Then (131.9 × 96) = 12662.4 cu. inches of oil in the tank. A British gal. contains 277.274 c. in. The tank, therefore, contains

$$\frac{12662.4}{277.274} = 45.66 \text{ gal. nearly.}$$

The formula stated above is very convenient and almost exactly correct. It does away with the necessity of applying the principles of trigonometry, which, to some engineers, are a somewhat tedious affair. However, we will work it out by another formula, as it may be interesting:

$$a = \frac{\pi 8^2 E}{360} - \frac{c}{2}(r - h)$$

Here we must find the angle (E), also the cord (c).

First we find the angle. To find ½ the angle we have the radius 12 in. and the side, which you can see is = (12 — 8) = 4in. That is when we drop a perpendicular from the center of the circle on the cord (c) we have a right triangle, the sides of which are ½ the cord, and the dotted line, and the hypo will be the radius. Two sides are known and one angle. In

$$\text{Angle } E = (2a)$$

$$\text{Cosin } a = \frac{4}{12} = .3333$$

Whence a = 70 deg. 30 m. and E = (70°—30') × 2 = 140½ deg.

Cb = cosin a = 12 × sin. 70° — 30'.

Cb = 12 × .94264 = 11.31168 inches, or say 11.31.

The cord c bd = (11.31 × 2) = 22.62.

Now we can apply the formula

$$a = \frac{\pi r^2 E}{360} - \frac{c}{2}(r - h)$$

Substituting

$$a = \frac{3.1416 \times 12^2 \times 140\frac{1}{2}}{360 \times (12 - 4)} - \frac{22.62}{2}$$

$$a = \frac{63560.7}{360} - \frac{22.62}{2}(12 - 4) =$$

$$a = \frac{63560.7}{360} - 11.31 \times 4 = 131.26$$

sq. in.

Another way that is very simple is to lay off to scale and run the planemeter over it as you would get the area of an indicator card.

Now, some of our readers are good at transposition of formulas, and some of them may like to try this. Transposing the formula

$$a = \frac{4h^2}{3}\sqrt{\frac{D}{h}} - .608$$

Find the height of the oil in the above tank when it is 3-5 full.

COMMUTATOR SPARKING TROUBLE

In conversation with the engineer aboard a certain tug in Halifax the other day, the chief mentioned some trouble he had with a sparking commutator on a small lighting turbo driven D. C. generator. He explained that he had electricians looking over the job a dozen times who assured him that the generator was in good condition, the brushes properly spaced and properly set, yet they could not stop the sparking on the commutator.

I asked the chief if I could look at his generator. "Sure," he said, and he went below with me and obligingly started her up. Well, she was sparking all right, although I have seen them much worse, but she was also vibrating badly and as the commutating speed was high I knew that the commutating trouble was partly, if not entirely, due to vibration. The machine seemed to be badly out of balance. Where the ball thrust should be there was nothing but the casing. I put my lead pencil up to the end of the shaft and found the end play to be about one-quarter of an inch. That is a lot for even a small turbine, and I steadied the rotor by holding the pencil against it and to my surprise the chief told me that the sparking stopped (I was at the other end of the machine). I questioned him about the speed, but he could not tell it exactly. I wondered why but I found out when he shut down that there was no governor on the turbine. The steam was controlled by the throttle. When the lights were bright the speed was assumed to be as it should be. This is not necessarily so, since the amount of resistance cut in will determine the voltage regardless of the speed. The generator had been rewound and statically balanced. A new wheel had been put on the turbine shaft and statically balanced, but the set was never balanced for running (dynamic balance). I looked for a crevice in which to stick a bit of lead to try for balance but could not find any on the outside of the revolving element, but I explained to the engineer how we used to insert balancing plugs in turbo generators. He brought me the old wheel that had been removed and I was able to show him the holes tapped in the disc for balancing and I may say that I had a great deal of respect for him taking it as he did. He was not too big feeling to take pointers on something that he just didn't happen to be clear on before, and the same fellow gave me a few tips before I left him.

Now he is going to balance his machine and take up end play and take some of the slack out of the bearings and if he can find the maker's address he is going to get a new governor and ball thrust, and if he finds that that doesn't cure all his troubles, well, I may as well keep my nose clear of Campbell's Wharf, as Conrad is a pretty burly looking fellow. J. A. McG.

WHY BELTS ARE STIFF

By RALPH BENTZ

An excellent way in which to make a study of belt fibre action is to take a pad of scratch paper, a magazine, or something of that sort, and bend it. It is easy to bend a pad of paper when the motion of the ends of the paper is unrestricted. You will note that one sheet slips along on the other a short distance. There is no tension on the convex side, or compression on the concave side of the bent pad. Glue the ends together, or hold the ends tightly with the hands, however, and it will be found more difficult to bend the pad. There will be a "buckling" on the concave side. The convex side will be in tension.

Next glue the complete pad together by saturating it in glue and drying, and you will have a chunk of material that will be as difficult to bend as cardboard, or even as difficult as wood. This is because buckling becomes impossible on the concave side if the gluing job is properly done, and there is no sliding. There is a certain plane close to, or at the centre, that is neither stretched nor compressed when the "board" is bent. That plane is called the "neutral axis." On the concave side of that axis the fibres of the board are in compression. On the convex side the fibres in tension.

The thicker the board the greater the force required to bend it. This is true because the fibres farthest away from the neutral axis have a longer lever arm than in a thinner board. And that is why steel I-beams, channels, Z-bars, etc., are made for engineering structures—to put the outside steel fibres as far away as practicable from the neutral axis.

This explains why belts may be stiff or pliable. The dry, hard leather belt that is not lubricated in its fibres is naturally stiff because the fibres have difficulty in rubbing one over the other. Thus you will find it more difficult to bend a pad of sand paper or emery paper, for example, than a pad of smooth writing paper. The dry, hard belt does not permit its fibres to slide on one another so easily on the tensile side nor on the compression side. The treated lubricated belt on the other hand, permits its fibres to slide with greater freedom. There is no "grinding" as in a pad of sand paper.

This method of studying the belt will clear away many of the points that have possibly been troubling many belt users. It explains why double or three-ply belts are stiffer than single belts. It explains why treated belts are more pliable than untreated belts of the same thickness. It shows why lapped cement joints have a tendency to loosen or "shear" and why the cement used in any belt must be good. Pick up a pad or magazine one-fourth of an inch thick and try it.

Low Pressure Heating Systems

HEATING systems supplied by low pressure steam from central heating stations are, as a rule, well protected from excess pressure by relief valves of ample capacity, and the whole system is usually under the management of competent and careful engineers who know their business. Moreover, these systems are daily inspected by the plant operatives and periodically by duly qualified Government inspectors or other recognized officials, and there is little danger of accident from over pressure. But in spite of the best regulations and frequent inspection accidents do happen, often with disastrous results and sometimes accompanied by loss of lives. To the duly qualified engineer there is no need to point out the precautions that should be taken with a view to safety, but there are engineers and attendants in charge of steam heating plants that may benefit from a few remarks. This applies particularly to those who operate small plants carrying high pressure steam for manufacturing purposes and reduce the pressure by means of a reducing valve for the heating system, or in some cases by throttling down on a valve at the boiler and controlling the supply of steam manually. In the latter case when more heat is required the valve is opened a little and when the steam supply is sufficient closed correspondingly. This practice has many disadvantages apart from the point of safety.

The Reducing Valve

The reducing valve is a device that, properly installed and operated, will maintain an almost constant pressure on the low pressure system even when the boiler pressure varies considerably. The fundamental principle of the operation is —that the low pressure steam acting on a large area will balance the high pressure steam acting on a small area. Let us take for example a case where the boiler pressure is 100 pounds per square inch and the steam pressure on the low pressure side is to be maintained at 10 pounds per square inch and ignore the weight of the valve disc, which is free to move, that is to close or open. Now if there be a continuous stem through to a cylinder above and below, each end of the stem to carry a piston, one cylinder to be connected to the high pressure steam supply, the other to the low pressure side, the area of the piston that is acted on by the low pressure side would have to be ten times greater than the area of the piston that was in contact with the high pressure. If we ignore the weights of all the parts that are free to move, we can prove this by simple arithmetic. Thus: Let us say the area of the high pressure piston is 10 square inches and the area of the low pressure is to be found. Let the pressures be as stated, i.e., 100 pounds and 10 pounds. Let (A) be the large piston area and (a) the small piston area. Then

$$10 \times A = 100 \times a \text{ or } 10A = 100 \times 10$$

$$A = \left(\frac{100 \times 10}{10}\right) = 100$$

The area of the large piston must be 100 square inches so that when there is 10 pounds per square inch on the low pressure side it will balance 100 pounds on the high pressure side and the valve remains in a neutral position. Now if the pressure on the low side tends to go above that point it will overpower the high pressure and the valve will automatically close and prevent more steam going over to the low side. We can also prove this by simple arithmetic.

Let us say that the pressure on the low side has increased ½ a pound per square inch and let the high pressure be (P_1) and the low pressure be (P_0) and the areas as before (A) and (a).

Then $(A \times P_0) = (a \times P_1)$ or $(100 \times 10\frac{1}{2}) = (10 \times P_1)$.

$$P_1 = \frac{100 \times 10\frac{1}{2}}{10} = 105 \text{ pounds per square inch.}$$

That is, an increase of ½ pound on the low side is equal to 5 pounds on the high side and so long as the pressure on the high side does not increase the valve must close. This also proves that under these conditions a variation of 5 pounds on the high side means a variation of 1-10 or ½ pound on the low side. Now if the boiler pressure falls off 10 pounds per square inch the heating system pressure falls off 1 pound. Later on we will take up the description of the various kinds of reducing valves in use, and how to take care of them and adjust them in practice. Now where does the safety valve or relief valve come in.

The Relief Valve

Let us say that something goes wrong with the reducing valve, and it fails to close when the pressure on the low side goes up. The disc of the reducing valve may not be exactly steam tight, or may be cracked. If some one closed the valves on the heaters the steam leakage through the damaged reducing valve would allow the pressure to build up. It is easy to see that the whole heating system would be charged up with steam at the boiler pressure, provided that there was no safety valve between the reducing valve and the heating system. The result might be a disaster. It may be said that the danger is not so great when the heating system consists of ordinary wrought iron or steel pipe with standard fittings but where there are cast iron heaters or tanks and receivers of large diameter there is great danger. Therefore there should be placed in every heating system that is supplied from a high pressure boiler, whether the steam supply is regulated by hand or by a reducing valve, a safety valve that has ample relieving capacity to relieve all the steam that could pass through the reducing valve when wide open without a dangerous increase of pressure.

The safety valve should be placed close to the reducing valve and on the low pressure side in every case. The size of safety valve of course depends on the quantity of steam that must be relieved per hour and the absolute pressure. The following formula is for the area of a safety valve:

Let (a) be the area of the safety valve in square inches.

Let (w) be the weight of steam to be relieved per hour.

Let P be the gauge pressure pounds per square inch.

$$\text{Then } a = \frac{0.22 \times w}{(P + 15)} \text{ and } w = \frac{(P + 15)}{0.22}$$

also $P = (0.22w) - 15$.

The installation of a safety valve of large relieving capacity at low pressure is very important, since what often happens when the reducing valve goes out of order is that the by-pass is opened wide out and the throttling is done from some convenient point maybe near the boiler and there is danger of it being thrown wide open by someone. Sometimes the reducing valve is blocked open and no attempt made to repair it when it goes out of order or the disc maybe taken out. This often happens where the reducing valve is installed without a by-pass.

The best reducing valves ever made will go out of order sometimes and besides there is always a chance of someone tampering with the adjustment. The result is the pressure on the heating system may become excessive, if not protected by a relief valve.

Wants Generator—G. L. Whidden, Lower Wentworth, Nova Scotia, is looking for a good, used, direct current generator, 30 to 40, on 110 volt, capable of giving from 600 to 750 amp. He would like to secure this complete with switchboard. He is also interested in a used lighting plant, with or without batteries.

Wants Feed Pump.—Vineland Canneries, Ltd., of Vineland Station, Ont., want to secure the following equipment. They would consider used, if in first-class shape:—Duplex boiler feed pump for two 125 h.p. boilers, 2 in. intake and 1½ in. discharge. Along with this is required a number of tees, nipples, check valves, etc. W. A. Whitney is the manager of the concern.

How They License Engineers in Nova Scotia

The Method Under the Colliery Engineers' License Law—In Other Steam Plants No License Required—The Licensed Engineers' View—A Particular Case—A Uniform Law

Special to "Power House"

SINCE 1894 there has been in effect in Province of Nova Scotia an act, known as the "Mines Regulation Act," its purpose being to regulate and cause to be examined by a board, the officials entrusted with the operation of coal mines, both underground and overground. Thus engineers are required to pass examinations in order to obtain certificates, entitling them to operate steam plants in connection with coal mines.

This act has been amended now and then for the past 15 years, with the result that the Colliery Engineers' License Law is reasonably comprehensive, and it may be said that so far as the coal mine operative engineers and hoistmen are concerned they must to-day hold a certificate of competency before they can operate a steam plant of more than 100 h.p. capacity at a pit-head. Why the minimum is placed at 100 h.p. and no mention of the steam pressure carried is not quite clear. But as the law stands at present a young man, 18 years of age, who has served six months as a fireman and can furnish proof of good conduct, and is a British subject, can sit for a certificate of competency and, if successful, may operate a steam plant of 100 h.p. and up to 200 h.p. carrying any steam pressure. More than that, he may operate his plant without inspection of his boiler, if the boiler is not insured, as the law does not provide for boiler inspection. Remember this 18-year-old engineer is (if he holds a certificate from the board) in full charge of the plant. I am not saying that 18-year-old boys are operating 100 h.p. plants in the capacity of engineer in charge. I am merely stating the law.

Other Steam Plants

Now we will leave the colliery engineer at that for the present and see what effort there is made to regulate other steam plants. I think I can show that there is none whatever, so far as license law or inspection regulations are concerned. It is quite common to see steam plants in the coal mines districts operated by engineers who have no license. They can do this lawfully so long as the plant is not part of the mine equipment. In some cases the boilers of the plant are inspected by the boiler insurance inspector. This applies only to boilers that are insured, and I am not just now concerned with insurance. Now then, coming down to steam plants that are outside of coal mine districts, Stationary plants in cities are operated by non-licensed engineers and are under no regulation whatever. Traction engines with boilers, road machines, donkey plants for contractors on construction work, steam heating plants in large public buildings and apartment houses, steam laundry plants, factory plants of all descriptions ranging all the way from 10 h.p. to 5,000 h.p. and pressures from 5 pounds to 200 pounds per square inch, are entirely at the discretion of the owner or manager as to who shall operate these plants and how they shall be operated in so far as the law takes any notice. I do not say that those engineers in charge are not qualified, in fact I know some of them are excellent engineers, but they haven't a scrap of paper to show that they are. On the other hand, I know that some of them are not qualified and who are not qualified to sit for an engineer's examination, and who would not be allowed to operate a steam plant of any kind where there are regulations in force. Some of the plants in charge of incompetent men may have a certain measure of protection in the fact that they are periodically inspected by the insurance inspector, but the insurance companies want business and can afford to take some risk. Sometimes they may take more risk than they know of.

Who is going to say that an engineer is or is not competent in the absence of an examination board? One may say that it is just one man's word against another's. I have had men come to me as engineers who were quite ready to step in and take full charge of a watch, who had a pocket full of recommendations, etc., who did not know the A.B.C. of steam boiler operation. On the other hand, I have had men come to me who did not have a scrap of paper who turned out to be A1 men.

The Licensed Engineer's View

Now let us have a look at the situation from the licensed engineer's standpoint. In order to take charge of a coal mine plant he has had to go up for examination before the board, year after year, until he now probably holds a 1st Class Engineer's Certificate. That certificate is good in any colliery steam plant in Nova Scotia and nowhere else. So long as he sticks to coal mine plants, he is regarded as a competent engineer. If he goes to a city plant he might just as well leave his paper at home, it will make him no friends in the city plant. In fact he would stand in better if it was not known that he had one. The master mechanic of the plant requires no ticket, the chief operating engineer probably had no ticket, and the manager or superintendent probably never heard of such a thing as a ticket for a stationary engineer. He will likely want to know why you require a ticket to put coal in the boiler furnace or put oil on the engine. If he goes to Montreal or Toronto or Winnipeg or any other place in the West with his ticket, it won't qualify him to fire a sawmill donkey boiler, let alone a steam plant of any size. Why? Because a certificate that is no good except in one corner of Nova Scotia is no good anywhere, and who's fault is it? We are going to look into that right now.

We can hardly blame the owner or manager of an isolated steam plant for being indifferent to any form of license law or boiler inspection regulation. He is like the fool that we all meet at some time or other, who did not know the gun was loaded. If he kills himself, we feel a little sorry for him. If he kills someone else—well, it was an accident; anyhow, we won't hang him and he is left free to do it again if he happens to forget. So the aforesaid owner, like the man with the gun, does not know that his steam boiler or his engine flywheel are loaded and are more deadly than a gun. There is no use telling him, he simply can't see it. Of course, he can't see it.

A Particular Case

The following case took place not 1,000 miles from one of the coal mine districts. The inspector of factories, under the Factory Inspection Act, had occasion to look in on an engineer when making the rounds of a certain plant, and noticed that every once in a while the engineer would adjust a very substantial looking hook. After a little he would disengage it, and not seeing any sense in the thing at first, the inspector became curious and investigated. This is what he found. Mr Engineer had a system of compound levers and chains so arranged that he could hold the safety valve down and leave it locked down close, without having to go up on top of the boiler to do it. When cautioned by the inspector about the danger (the factory inspector has nothing to do with boiler inspection) the engineer (?) showed him that he know something, "He was no hick, he wasn't." He explained, "This boiler was tested to so and so pounds per square inch and she didn't explode. Besides you should know, if you know your business, that this boiler was constructed with a factor of safety of 5, and there is no danger of an explosion even if I increase the pressure to five times the blowing-off pressure."

That man should have been fired on the spot, but it couldn't be done—he was in charge of the plant, and as long as the owner could get power he was

(Continued on page 42)

The Purification of Boiler Feed Water

Process of Continual Blow Down Used in Conjunction With Hot Purification—The Author Describes His Own Process—Various Causes of Corrosion and Need for De-Gassing Water

By PAUL KESTNER

A JOINT meeting of the Institute of Mechanical Engineers and the Society of Chemical Industry was held in London on March 4, to hear a paper by M. Karl Kestner on "De-gassing and Purification of Boiler Feed Water." Captain H. Raill Sankey, president of the Institution of Mechanical Engineers, was in the chair, and Sir William Pope, F.R.S., President of the Society of Chemical Industry, was also present. As will be seen, the meeting was regarded as of considerable importance, inasmuch as it brought together for the first time mechanical engineers and chemists. M. Paul Kestner is founder and president of the French Society of Chemical Industry.

M. Kestner said that the necessity for enabling boilers to steam for long periods without scale or corrosion becomes more urgent every day. The old lime and soda process had been improved and reduced in size, and heat had been used to accelerate the operation, but not always with success, for in some instances a concentrated soda solution was formed in the boiler.

The paper dealt in detail with the process of continuous blowing down used in conjunction with hot purification. Hot purification effects a thermal saving, and has the further advantage of eliminating the gases dissolved in the feed water by the reduction in high solubility at high temperatiure. The speed at which the reaction takes place in the purification of water by soda alone, or lime and soda, can be accelerated by heat, and the settlement of the precipitate can be hastened by agitation, the effect of which is to cause accretion and increase of size of the particles. If the agitation is caused by a stream of water carrying air with it, the water becomes saturated with oxygen and corrosion results.

In water-softening processes generally, rise of temperature ensures (a) increased speed of reaction; (b) reduced viscosity of the water; (c) reduction of the carbonates of the alkaline earths to carbonates; and (d) reduced solubility of calcium sulphate and partial precipitation without the use of reagents.

Whatever method of purification is employed, all the salts carried into the boiler by the feed water become concentrated in it. In general some calcium carbonate remains in solution in the water and when the concentration produced by evaporation becomes sufficiently high it is deposited on the walls of the boiler or in the tubes, forming incrustation, which is harder the more slowly the deposit is made. In boilers generating steam very rapidly, the deposits are also formed rapidly, and may accumulate in the tubes notwithstanding the violence of the circulation. The usual remedy is periodic blowing off from the lowest point in the boiler, and, to be effective, a large actual quantity of water must be blown off at each operation, even though such should not form a large proportion of the boiler contents. The continuous blow down allows the calories to be saved by passing the blow-down water through a feed-water heater, the mud being deposited in a trap during the process, together with the salts that had been retained in solution owing to the high temperature of the liquid. The only loss occurs in the actual removal of the mud and salts, which form a relatively small quantity The blow-down water freed from the impurities is then returned to the boiler. This prevents the concentration of the soluble salts to an extent at which they would constitute a danger.

The process of continuous blowing down permits the contents of the boiler to be renewed frequently; it eliminates mud before it has time to accumulate, and at the same time allows the use of soda for the reduction of the calcareous bicarbonates. The feed water, therefore, contains sodium carbonate and bicarbonate; the latter is decomposed in the boiler to carbonate, and the carbonate in its turn is dissociated in the presence of water with a reversible condition of equilibrium in functions of the initial concentration and the temperature, thus CO_3Na_2 H_2O $2NaOH$ CO_2, hydrolysis giving more caustic soda the higher the temperature. With continuous blowing down, the water containing caustic soda and carbonate of soda is used to purify the make-up feed, the caustic soda reacting more rapidy on the calcium bicarbonate than would calcium oxide. It is, therefore, said the author, of great importance to combine purification by soda with the continuous blowing-down process.

M. Kestner then described the Kestner continuous blow-down process, the apapparatus consisting of a steam separator, a central reservoir receiving the blow-down liquid, an annular chamber surrounding this reservoir, from which it receives heat and into which the purified blow-down water is decanted. The steam passes into a re-heater in which it heats the feed. The decanted feed mixes with the blow-down as it leaves the central chamber, and then passes to the annular chamber in which precipitation and settlement take place. Soda is added through a water meter in proportion to the make-up feed. Valves are provided for separating the mud.

Discussing the conditions in which distilled water is used in industry, the author stated that this water is very different from that used in the laboratory. Owing to the rate of evaporation, particles of water containing salts are carried over, so that the distilled water contains numerous soluble salts in small, but by no means negligible quantity, and in the boilers using distilled water it becomes in time a fairly concentrated liquor. Boilers working with distilled water, therefore, require to be blown down occasionally, but it is not necessary to remove a large amount of liquid, the amount being usually only 1 or 2 per cent., the saline solution being replaced by distilled water. Even when an evaporator is used, the continuous blowing-down method can be adopted, and, in conjunction with de-gassing, enables a complete closed water circuit to be arranged in a central station using distilled water. Where distilled water is used, continued the author, there can be no doubt as to the cause of corrosion. Oxidation of the plates can only be produced by oxygen dissolved in the feed water and set free in the boiler, and the effect is greater with intermittent working. The theories of corrosion were discussed, and the need for de-gassing purified water was pointed out, it being explained that the critical concentration, at which maximum corrosion by salts is effected, must be exceeded after a few hours' work in ordinary boilers. Electrical and electrolytic action were next considered as well as the hydrolysis of magnesium chloride, as was the action on steel of carbonic acid gas alone and in the presence of oxygen, as well as the formation of oxy-salts under certain conditions. As regards the elimination of oxygen in solution, the author showed that the air dissolved in water contains roughly 33 per cent. of oxygen, and a titrating method of controlling the de-gassing, devised by M. Gaston Paris, of the Kestner laboratory, was illustrated.

The elimination of the oxygen dissolved in water may be effected either by physical or chemical methods, or by both. Of the former, the principal methods are agitation of the water, the action of temperature, and the action of vacuum. These may be used separately or in the majority of cases in combination. Of chemical methods, the only one that is important is the action of highly oxidisable iron, which absorbs the oxygen from the feed water. Brief descriptions were given of the methods and appliances for de-gassing by physical

means, and M. Kestner then discussed the more important classes acting by (a) combined physical and thermal means. The Cochrane, Webster, Weir and Chevalet heaters are placed in this class. The Aerex was said to have certain advantages over these, which are adopted also by Seigmon-Schmitt. (b) Vacuum de-gassing. In this class were placed the vacuum appliances of Meihof (Halvor Breda) and Griesheim Elektron Lauta (Balke and Company) and Deutsche Sanitas Werke. The de-gassing apparatus of the Elliot Company, of America, working at about 100 degrees Cent., was also mentioned. (c) Chemical de-gassing. Under this heading it was explained that the chemical methods in use are all based on one principle of using very easily oxidisable iron, which, under suitable conditions, enables de-gassing to be obtained down to only traces of oxygen. As the result of much experiment, the author has found that for this purpose manganese is a catalytic agent of great importance, and a suitable manganese cast iron has been found. Mention was also made of two German de-gassers, the Seiffert and the Halsmeyer, which work with rusted iron, and there is also an American apparatus, due to Professor W. H. Walker, styled a "deactivator."

The author's experiments have led to the design of an apparatus due to the discovery that when an iron de-gasser which had become completely rusted was left at rest, it was found after a day to have undergone a change, and from red rust to have become greenish-black, due to the reaction of ferric hydrate under the influence of the iron. This led to the invention of the Paris de-gasser, which works on the regeneration principle; in one form by means of two vessels containing iron turnings through which flow takes place alternately, and in the other form in a single vessel with filters at each end and a valve arrangement for permitting the direction of flow to be altered. The amount of iron used in the apparatus is stated to vary from 1 to 3 grammes per ton of water treated, and the amount so used corresponds to the weight of boiler plate saved from destruction. Finally, the suggestion of a water circuit closed from atmospheric contact was discussed and the combination of a de-gasser with such a system was recommended as a means for preventing any harm due to access of oxygen from accidental causes.

A fire which broke out late Saturday afternoon, May 8, at Queenston, in the power house of the Queenston-Chippawa development, damaged plant and equipment to the extent of about $50,000. While the actual damage itself seems large, it will not retard the schedule for the completion of the work at all, nor will it cost the Hydro-Electric any money. The origin of the fire has not been determined.

How They License Engineers

(Continued from page 40)

satisfied. As he was getting sufficient steam pressure under the present engineer he no doubt thought he had a first class man. What would happen to you with your first class ticket in that plant if you took the job and tried to convince the owner that the boiler was not safe at treble or double the working pressure? Why, you'd get fired on the spot. The other engineer could get steam, but you had cold feet. That's the way he might look at it.

Now, again, whose fault is it that such conditions are allowed to exist I may say that I believe that is partly the fault of the engineers who do not know that the gun is loaded. They allow the ignorant man to keep on operating and the owner likes it. No, if an engineer is not a safe man in a colliery steam plant how can he be a safe man in any steam plant

Probably the real reason that there is no regulation at present outside of the mining districts is this. In the early days of Nova Scotian industrial development, the coal mines were the only places where steam was used to any great extent. The first stationary steam plants of any importance in the province were hoisting and pumping plants at the collieries, and for years before this the British collieries regulations were in force, under which the colliery engineer had to pass an examination before a board. The Nova Scotia Government, following in the footsteps of the Mother Country adopted and put into force the Mines Regulation Act, and it is only within recent years that industrial development has spread to other centres than collieries. With this development has come the Factory Inspection Act of Nova Scotia and the Inter-Provincial Steam Boiler Act, which is soon to be adopted in Nova Scotia and of which something will be said at a later date.

It would appear that the Province of New Brunswick is leading Nova Scotia in the matter of steam boiler inspection and engineers' license regulations, as there is now in force in that province a law that requires the engineer of a steam plant to have a license to operate steam plants, whether in the cities or outside. The New Brunswick Boiler Law will be discussed through the columns of Power House at a later date. At present there are efforts being made to have a uniform boiler law in force all over the Dominion and there is reason to suppose that within a decade we will see a uniform boiler law in force all over the American continent.

Stanley Shupe, of Oshawa, has been appointed as city engineer of Kitchener, Ont., at a salary of $2,500. Mr. Shupe has had considerable engineering experience in Toronto and Oshawa and at one time was employed in Kitchener. At present he is the engineer at Oshawa

A DAY WITH THE HALIFAX STATIONARY ENGINEERS

BEING an engineer (at least in name) myself and not having any pressing business just at the time I decided to go out and see the plants in the city, or at least as many as I was allowed to visit and have a chat with the boys. As I had not been around much in the last two years, and having very little acquaintance with the engineers of Halifax I was not quite sure that the old password would work, but then I reflected, once an engineer always an engineer, and as I had eaten my bushel of coal dust and ashes like most of them I started out, after having put a plug of Montreal twist in my pocket.

The first place I visited was Camp Hill. I enquired for the resident engineer, Mr. Hobson, Not finding him, I went right into the boiler room and met a cheery, happy-go-lucky fellow from Sydney, who informed me that the chief engineer was not far away. I went around to his office and asked if I could see the chief.

"Right here, sir," sang out a young, gentlemanly looking fellow, who looked more like a doctor than an engineer.

"Well, how's she chuckin' her mud?" said I.

"Divil the finer," said he. "How goes it?"

"Well, it won't fry a spit yet," says I.

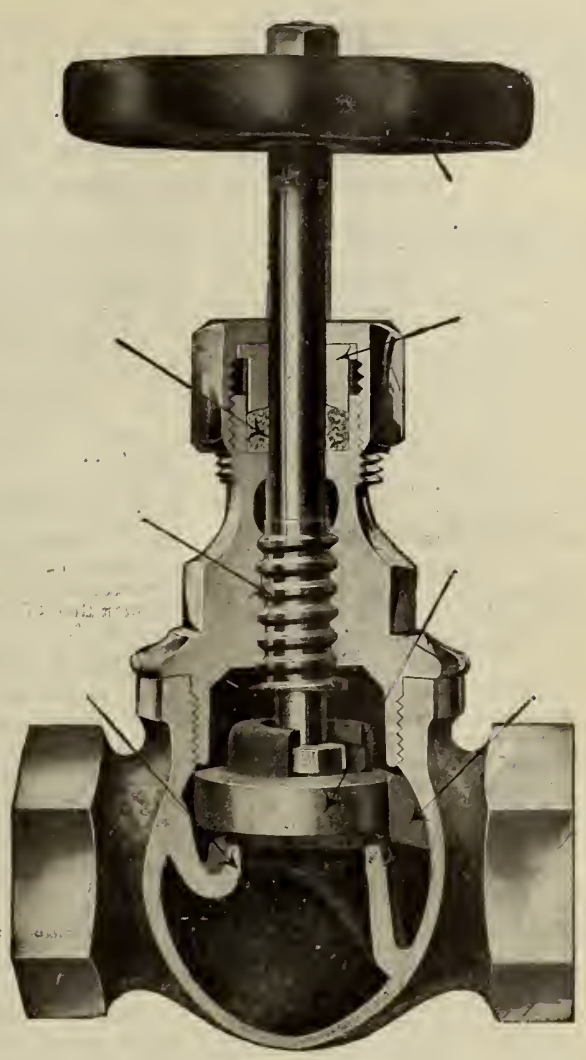
We got into conversation right away and when we got a little better acquainted he called his assistant and introduced me and gave me permission to look around.

Well, Mr. Phillips (the chief engineer) has about 300 boiler h.p. at the hospital plant, has a nice little refrigerating plant and a very extensive heating system. The boilers consist of three locomotive type, one R. T. and one water-tube. The boiler plant is far from up-to-date, there being many objectionable features. The present staff are of course not responsible for this as the plant was installed before Mr. Hobson came back from overseas. So they are doing the best they can with a poor outfit.

The firing aisle is about 4 feet wide and the coal is dumped in a storage bunker at one end of the aisle. There is a distance of approximately 60 feet from the bunker to the last fire door. The coal is wheeled in a hand barrow and dumped on the floor. The ashes are wheeled up an incline to a dump outside where they are shoveled into a motor truck. The incline is about 40 feet long and 14 feet high. There is an incinerator situated back of the boilers and the boiler feed pumps are in a well at one corner at the rear. The pumps completely fill the well or pit. If repairs are to be made the repair man must stand on top of the pump or lie flat on the floor and reach down, because there is not room for a man's foot in the pump

(Continued on page 45)

You don't scrap a machine when a bearing wears out



Neither do you throw away a faucet when the washer wears out. You simply put in a new washer, costing but a few cents. This is why

FAIRBANKS VALVES

reduce your valve maintenance to a mere fraction of your present cost. When the disc wears out a new one is easily substituted by anyone in a few minutes and the valve is then as good as new without being taken from the pipe line. Our nearest branch will gladly send interesting valve information.

If it isn't here —write us

Fairbanks Valves
Heating Equipment
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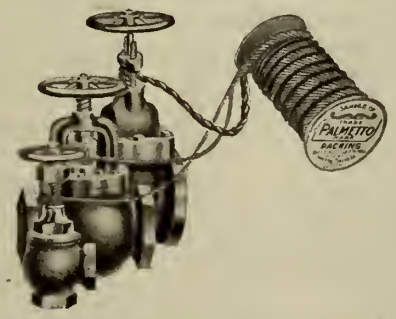


"Palmetto" Twist Packing is more economical because it standardizes buying. Any size packing can be made from a spool of "Palmetto" because each single strand is lubricated separately and is a perfect packing in itself.

Let us send you a free sample spool to test. Write our nearest branch.

The Canadian Fairbanks-Morse Co., Limited

Canada's Departmental House for Mechanical Goods

Halifax	Ottawa	St. Catharines	Winnipeg	Calgary
St. John	Toronto	Windsor	Regina	Edmonton
Quebec	Hamilton	Fort William	Saskatoon	Vancouver
Montreal				Victoria

Fairbanks-Morse

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	29 50
1¾-in.	29 75	27 00
2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
3½-in.	63 50	43 50
4 -in.	85 00	55 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$5 25	$5 25
Plates, ¼-in. up	4 75	4 75

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.

4½-in. and larger, 40%.

4-in. and under, running thread, 20%.

Standard couplings, 4-in. and under, 20%.

4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list: class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 87½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15
Standard	0 15 to 0 40
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7-16 and over	—5
Machine bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 27½
Solder, guaranteed	29½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl.	4 50
Sandpaper, B. & A. list, plus	43%
Emery cloth list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$32 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	34 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	40 00	42 00
Copper sheet, planished, 16-oz. base	46 00	48 00
Braziers', in sheets, 6 x 4 base	38 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13½
X L C R	14½		

Colored

Lion	13½	Popular	10½
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Mont.	Toronto
Tin	$39 00	$40 00
Spelter	7 75	7 50
Lead	5 75	7 50
Antimony	8 00	8 25
Aluminum	34 50	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.

Cut sheets to size, 1c lb. extra.

A DAY WITH THE ENGINEERS

(Continued from page 42)

pit, let alone room to work. The returns from the heating system flow to the feed pump by gravity. From the points below grade the returns are pumped by an automatic control operated rotary pump.

High pressure steam is generated at the main boilers to operate the laundry and a reducing valve steps the pressure down for the heating system.

The chimney, a concrete one, is about 50 feet above the grates. Owing to the boilers being below grade, the chimney top does not clear the highest point of the buildings. However, as the occupancy of the building is only temporary, Mr. Hobson will not likly undertake any changes. His predecessor got fed up with the job in six months and I don't think Mr. Hobson exactly loves it. It is a pity about the steam plant as the hospital proper is really up-to-date in every other respect.

From here I went over to Victoria General Hospital steam plant. I did not want to go through much red tape so found my way in without looking for a pass. I saw a fellow standing in the engine room door, with a cold calculating look in a bold eye (I did not need to ask for the chief, I could see it sticking out all over him). Well, this was Mr. A. Morash. He was a little suspicious of me when I came around and I think he was still suspicious of me when I left, but just the same I found him interesting and, let me tell the world, that Morash has a few ideas about engineering. He speaks right out in the meeting and calls a spade a spade. On the whole I liked him and I am going to see him again when I happen to be around. He is making some changes in the heating plant and some changes are being made without his approval, entirely, but he was pretty busy and I promised to come again. Morash is assisted by his son, who looks every inch an engineer and no doubt admires his dad.

In the boiler room I met Mr. F. A. Smith, a young returned man with ambition written all over him, in fact the whole engine room staff of this plant looked good to me.

At the City Home "steam plant" I met Mr. Grant, the chief engineer, a fine, quiet mannered man and a very interesting talker. He has a pretty old plant but keeps it in good order. Like his neighbor, Mr. Morash, he is making some improvements to his steam heating system.

I thought I'd seen enough hospital plants for one day, as I was anxious to get down to the tramway power house to have a chin with Mr. Freeman and my old friend, Tom Kelly. But on my way there I just thought of another old acquaintance who is engineer at the Westminster Apartments, Paddy Travers is his name. So I called to see him. Paddy used to be second with Mat Doyle at the Technical College steam plant. They kicked along together for seven years. Mat was chief and is so still, but now Paddy is chief in his own bailiwick. Well, Paddy outdid himself to show me around. He has a new plant, modern in every way, and he is proud of it. Here I made a new acquaintance in Mr. Wakham, who is putting in the steam system. He is a hockey fan. I used to meet him at the games and there we don't wait for an introduction. Wakham says he was just a little disappointed that the Crescents lost out in the League. That, so far as I know, is the only point on which Wakham and I differ. So far I think the Wanderers deserved to win.

Well, I left Paddy Travers and made for the tramways power house. Mr. Freeman was just going out to keep an important engagement, but he received me with a smile, and believe me, Freeman's smile is "some smile," and with it he rules one of the largest power establishments in the East. He is superintendent of power and chief engineer, and can brag of one of the best operated power plants in Canada, both from an efficiency and economy standpoint and continuous service. (An article on this plant will appear later.) Mr. Freeman is ably assisted by Tom Kelly in the engine room and Mr. Fry in the boiler room. I am not so well acquainted with the electrical staff, but the plant operation goes to show that the staff one and all are A1 men, so why shouldn't Freeman wear a smile.

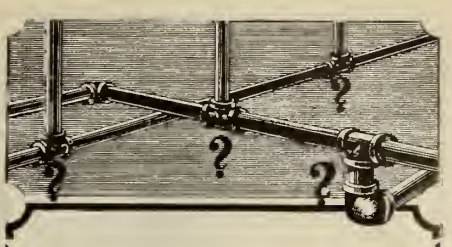
From here I went to see Cummings at the Atlantic Fish Company's cold storage plant. I met Cummings before. He has the only cold storage plant of importance in Halifax, and he sure has a nifty looking proposition. Cummings is a progressive young man with lots of pep, and while his plant doesn't look much from the outside, that old shell covers a bang-up cold storage equipment. Cummings has been chief of this plant for some years though he is only a young man.

From here I went to Moir's factory, where I met Murray Mosher and Theodore Stroude, both of them old acquaintances. Mosher was my assistant in a large plant east of here some years ago. He used to speak of Vincent Scott at that time. Well, I heard so much of Scott that I felt as if I knew him. Scott is the chief engineer at Moir's. So the boys located him where he was busy in another part of the factory, and made me acquainted. My impressions of Scott formed before I met him were that he was a good fellow or he wouldn't be so popular. Well, he is just that.

Scott has a big job and is continually improving the plant and it is easy to see that he knows his business.

MIKE CHROMETER.

Plans are being prepared by Brodeur and Pilon, architects, 63 Hotel de Ville, Hull, Que., for a factory to cost $15,000 for the Ottawa By-Products Co., Montclair St.



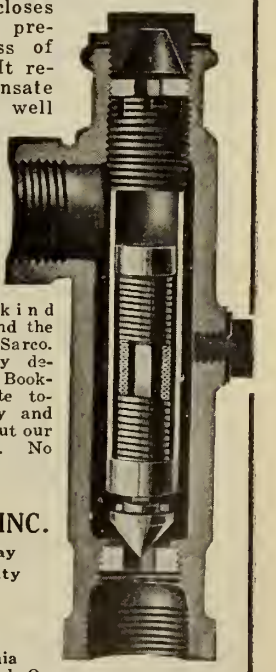
You're Wasting Coal If Your Steam Lines Are Not Thoroughly Trapped!

Because of the high cost of the "bucket" or "float" type of steam trap, many large plants are not equipped with a sufficient number of traps to take care of the condensate properly. A pretty poor policy, and one that is likely to prove very costly with bituminous coal selling at present high prices.

To be properly trapped — and that means economically trapped —a steam system should have a trap at every point where condensate collects.

The low price of the Steam Trap Sarco enables you to buy three traps for the cost of one of the bucket or float type. In that way you can equip your lines with as many traps as are needed, at a low figure, and in that way save many tons of costly coal.

And that is not the only advantage of this trap. Built on the liquid expansion principle, it is free from the complicated mechanism found in other traps—mechanism which will get out of order and cost you money for repairs.



The Sarco closes promptly and prevents all loss of live steam. It returns condensate to the hot well while still hot.

Can be installed without supports or platform.

There are other exclusive features of a money-saving kind which recommend the Steam Trap Sarco. These are fully described in our Booklet J-12. Write today for a copy and information about our free trial offer. No obligations.

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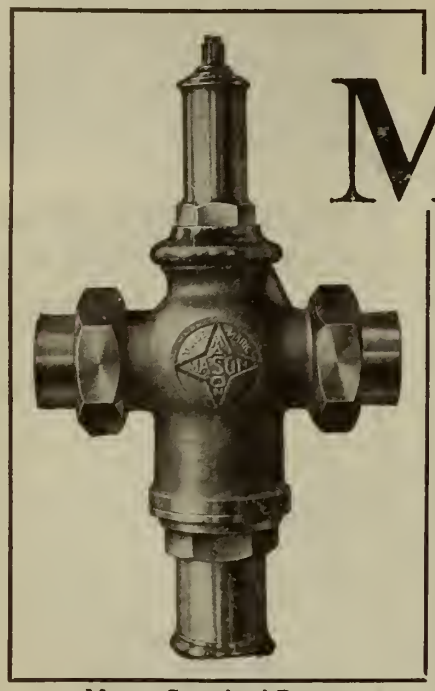

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For over forty years now, Mason Power Plant Devices have been the standard with careful engineers. Mason equipment, which includes Reducing Valves, Pump Pressure Regulators, Steam Traps, **Reilly Feed Water Filters and Grease Extractors,** is satisfactory because it leaves nothing to ask for in the way of lasting, accurate service.

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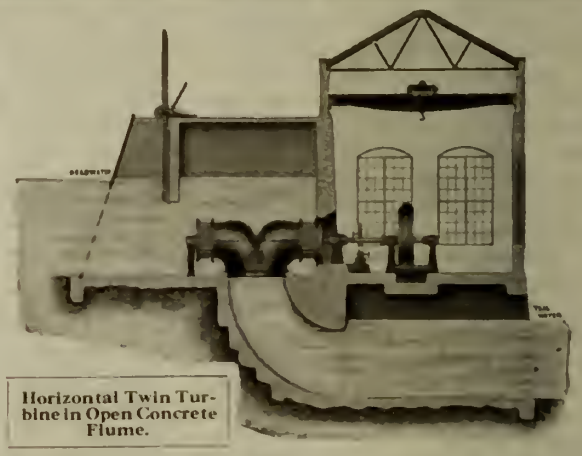

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Water Wheels and Hydraulic Power Plant Equipment

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Simple Yet Comprehensive

For efficient operation the Steam Flow and Air Flow records come together and show as a single record. When excess air is entering the furnace, the Air Flow record shows above the Steam Flow. The opposite is true when the coal feed is too great and the fires are not receiving sufficient air.

The record of the Flue Gas Temperature made on the same chart indicates the relative condition of the baffles and tubes. The Fire Box Draft is indicated for assistance in maintaining balanced draft conditions.

Bulletins upon request

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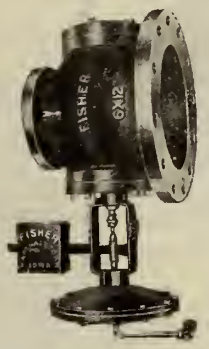

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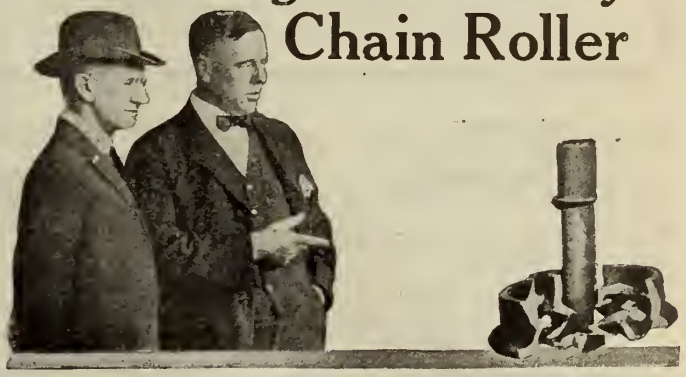

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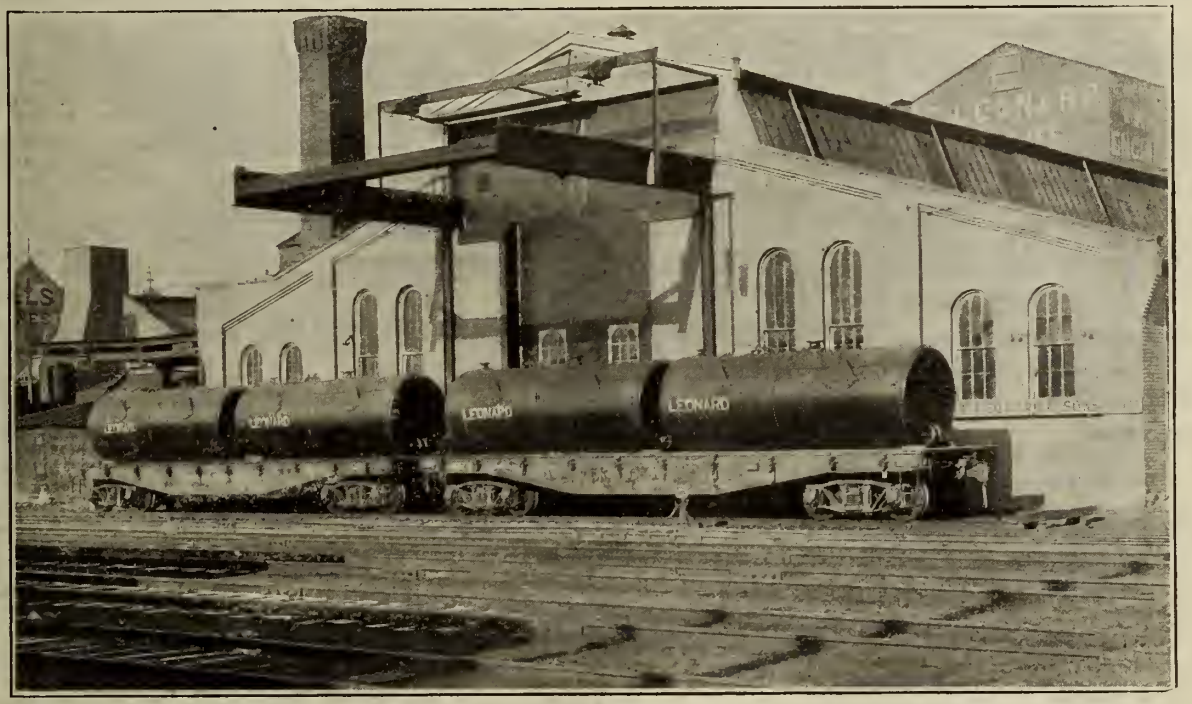

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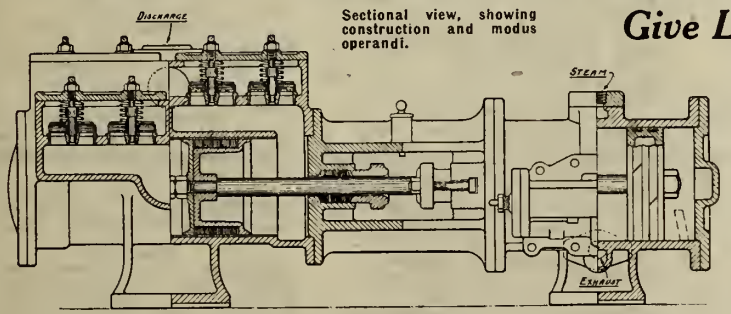

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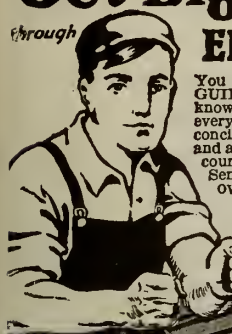

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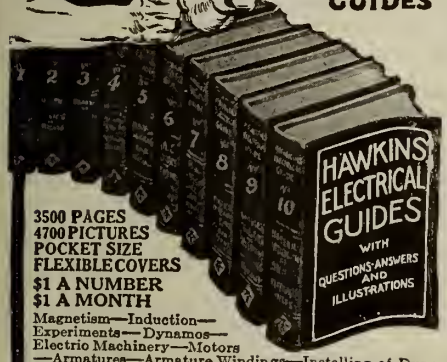

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American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Lanrie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, ELECTRICAL—ALL TYPES
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER BELTING
W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal, Que.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Green's Economiser, Ltd., Toronto.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd. Montreal
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

Here are the men who place and influence big business. They are the men who read your message when conveyed through the columns of this paper.

The Pivot Men

of Canadian Industrial Activity

THESE men are keen on efficiency, on getting things well done, on saving labor, on saving time, on putting the best into their work and getting the most out of it. These are the pivot men of Canadian industrial progress. They are the men who keep abreast of the times by habitually reading reliable Canadian technical newspapers.

They are the men who buy or influence the buying of the products you market.

If you have a product to sell you can reach these men easily and inexpensively by presenting your message to them repeatedly and intelligently through the columns of their favorite technical newspaper, a publication that commands their respect and attention.

Such a paper must necessarily possess an editorial appeal of the highest order. It must be an authority in its chosen field. It must be free from glamour and pose and bluff.

Technical papers entitled to rank in this class are included in the membership of Canadian National Newspapers and Periodicals Association. Membership in this Association assures the highest standard of editorial ideals—in fact the highest standard in all departments. A careful and detailed analysis of Power House may be obtained on application to the publishers.

Following is a list of worth-while, reputable technical newspapers which are members of this Association and which constitute its Technical Newspapers Section:

Canadian Engineer
Canadian Foundryman
Canadian Machinery
Canadian Manufacturer
Canadian Railway and Marine World
Construction
Contract Record & Engineering Review
Dominion Dental Journal
Electrical Dealer & Contractor
Electrical News
Marine Engineering
Municipal World
Power House
Sanitary Engineer

Canadian National Newspapers and Periodicals Association

70 Lombard Street, Toronto

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
W. J. Brown (Tucks), Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ort.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co. Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Inglis Co[illegible] John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Darling Bros Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co. Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Hays Corp., Michigan City, Ind.

RECORDEDS CO2
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.
Uehling Instrument Co., New York, N.Y.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 23 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Paper Co., Ltd., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
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SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
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Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
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Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

Just to again remind you that the

Republic Flow Meters Co. of Canada
LIMITED

will in future be known as

Dominion Flow Meter Co., Limited

The organization has been augmented (retaining the original personnel) to carry on the ever-increasing business, and we trust this change will continue to merit our customers' confidence.

The design of our equipment is in no way changed, and the service will be of the same high standard in the future as it has been in the past.

If ever there was a time when Engineers required the moral and physical support of co-operation with their brother engineers, it is now.

Canada, to-day, after 5 years of intensive production, has been struck by a period of slackness. We are now faced with the necessity of not only not producing at normal rates, but of curtailing the services and expenses so far as it is humanly possible to do.

The engineer has been called upon to do without many things which in his opinion are absolutely necessary, and in many cases he has on his hands apparatus which has largely become unnecessary.

The result of all this is that he must convert the unnecessary to the necessary, and make shift with what he has in the most efficient way. Realizing this, and the necessity for co-operation, we have instituted what we call a Service Department.

This Department, we feel, is fully qualified to deal with any and all kinds of Power Plant problems. Our Service Department will not stop at giving service on our apparatus, but will be glad indeed to co-operate in any way with any engineer who cares to make a call upon this Department for consultation, or service of any description.

In this way we hope to cement the friendship which we have with all our clients, and many who are not our clients, and to be of service generally in this time of reconstruction.

Yours for co-operation,

(Sgd) E. C. Hanson.
Engineer,
Dominion Flow Meter Co.,
Limited.

Dominion Flow Meter Co., Limited

145 West Wellington Street

Toronto, Ont.

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Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM CALORIMETERS
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STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
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Lincoln Electric Co. of Can., Ltd., Toronto

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MacKinnon Steel Co., Sherbrooke, Que.

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Green's Economiser, Ltd., Toronto.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

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MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa

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The Superheater Co., Ltd., Montreal.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM SHOVEL
The Superheater Co., Ltd., Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

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J. H. Williams & Co., Brooklyn, N.Y.

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Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

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S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
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Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
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Waterous Engine Works Co., Brantford.

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Crane Ltd., Montreal
Dart Union Company, Toronto.
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Dart Union Company, Ltd., Toronto, Ont

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Boving Hydr. & Eng. Co., Ltd., Lindsay
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Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Darling Bros., Ltd., Montreal, Que.
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Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
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Jas. Morrison Brass Mfg. Co., Toronto
Shell Bar Boico Supply, Ltd., Toronto
H. Mueller Mfg. Co., Ltd Sarnia
Valve Engineering Company, Toronto.
Homestead Valve Mfg. Co., Pittsburg
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd. Ottawa.
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Hoyt Metal Co., Toronto.
Kerr Engine Co Walkerville, Ont.
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VALVES, BACK PRESSURE
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Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg Co., Pittsburg
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co. Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

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Kerr Engine Co., Walkerville, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co. Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

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Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

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Kerr Engine Co., Walkerville, Ont.
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Shell Bar Boico Supply, Ltd., Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

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Dominion Steel Products Co., Ltd., Brantford, Ont.

VALVES, MULTIPORT
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Jas. Morrison Brass Mfg. Co., Toronto.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.

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Can. Johns-Manville Co., Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

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Jenkins Bros., Ltd., Montreal
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Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sarco Company, Inc., New York.

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Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Dominion Steel Products Co., Ltd., Brantford, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.

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Pratt & Cady, Hartford, Conn.

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Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

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Armstrong Mfg. Co., Bridgeport, Conn

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R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto

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W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
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Wm. B. Scaife & Sons, Pittsburgh, Pa

WATER PAINT
Beveridge Paper Co., Ltd., Montreal

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

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Shell Bar Boico Supply, Ltd., Toronto

WASTE
R. C. Miller Oil & Supply Co., Ltd., Montreal

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
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WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
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Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WIPERS
R. C. Miller Oil & Supply Co., Ltd., Montreal

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

With LABRIDE Equipment

Coal Can be Handled at Rate of 100 TONS per hour

WITH ONE MAN HANDLING IT

BY means of moving bridge and cross-travelling trolley the bucket can reach any part of yard within a minute or two.

LABRIDE can serve Canadian plants as effectively as it has in the United States.

Write us for information.

Lakeside Bridge & Steel Company, North Milwaukee, Wis.

How to Test Advertising

THE man who doubts the power of advertising belongs in the same class with the man who refuses to believe that the world is round simply because he can't get off somewhere at a distance and see its roundness for himself.

The merchant who fears to attempt advertising because he figures it as an "expense" is blind to his own interests. I personally know several men who, because they once tried advertising to the extent of a cheaply printed hand-bill and didn't find it necessary next morning to call on the police to keep the crowds of eager buyers from swamping their store, loudly and solemnly aver that "advertising doesn't pay."

Advertising *does* pay.

The most successful merchants are the merchants who believe most thoroughly in advertising and who practice their belief.

But advertising, in order to pay, has got to be *intelligent* advertising.

The day of hashed-over superlatives — "best goods," "lowest prices," "best stock in town," "greatest bargains ever heard of," and so on—has passed.

People have learned to distinguish the *truthful* advertiser from the blatant behind-the-times storekeeper who believes that, so long as *he* claims to have the best goods on earth, or under the earth, or within wireless distance of the earth, people will break their necks trying to get to his counters in the forefront of the crowd.

Put some *brains* into your advertising.

Don't let the office boy write your announcements in between his other duties.

Don't doubt the business-getting and business-building power of intelligent and informative publicity — and you will find that advertising *does* pay.

—Jerome P. Fleishman.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

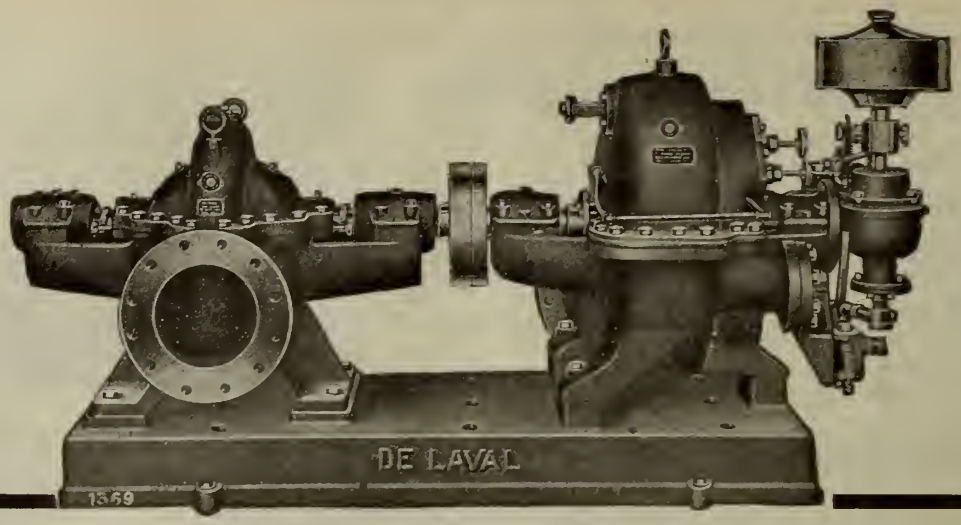
Drop us a line and let us tell you all about this Remarkable Packing and our "SAFETY" Superheat Sheet Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes



De Laval Turbine-Driven Pumps

COMBINED with the De Laval steam turbine, the De Laval centrifugal pump forms a compact, reliable and simple unit, which occupies only a small fraction of the space taken by a reciprocating pump and requires only light foundations or none at all. The turbine and pump are both simple and accessible, and require practically no attention. By providing additional nozzles, it is possible to operate with reduced steam pressure, maintaining full water pressure under conditions where a reciprocating pump would fail.

Describe your conditions, and our engineers will supply full information. Ask for Catalog B-100.

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LTD. 73 King St. W., Toronto

THE E. LAURIE COMPANY 243 Bleury St., Montreal, Que.

TAYLOR ENGINEERING COMPANY, LTD. Vancouver, B.C.

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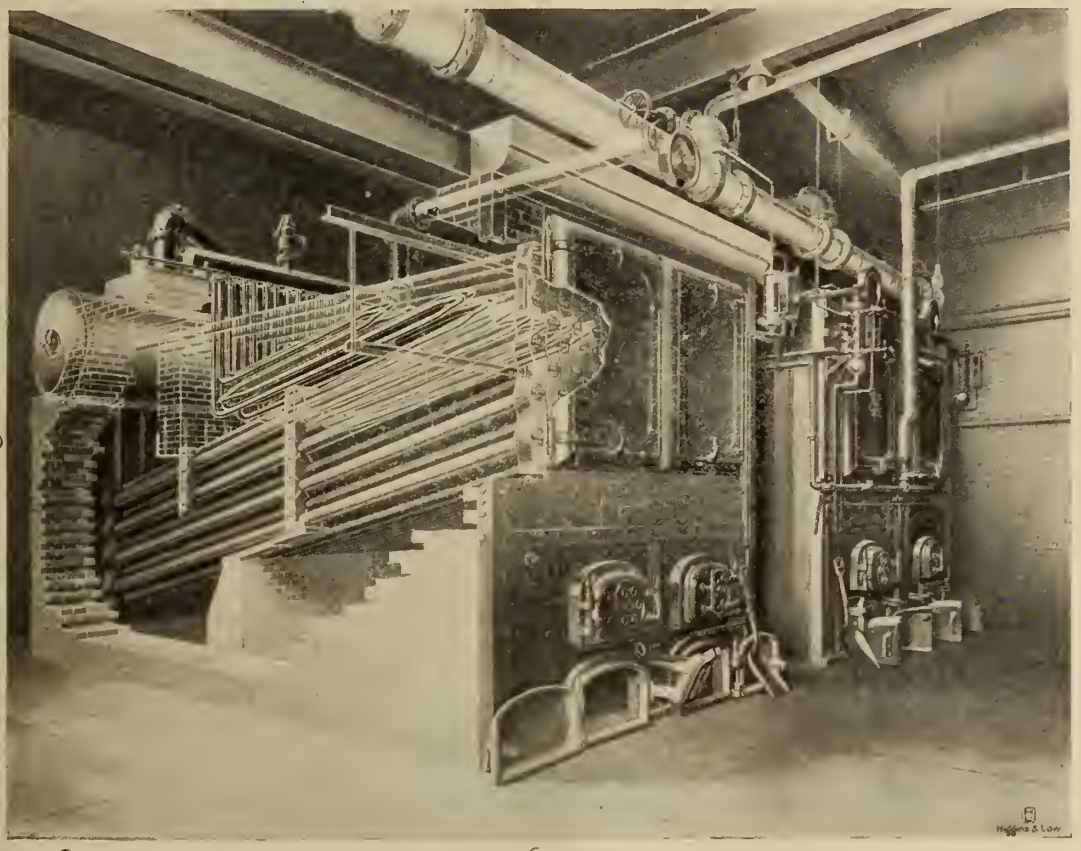
WE — FU — GO AND SCAIFE

WATER

PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

ELESCO SUPERHEATERS



Modernizing by the Application of ELESCO SUPERHEATERS Saves Fuel

MORE reasons exist today than ever before why existing steam power plants should be superheated. While until a few years ago the scrapping of old plants and the erecting of new was justifiable to effect gains in economy, such a procedure today is seldom warranted because of high material and labor costs and because of the recent development of economy increasing factors.

The practical course open is that of modernization, wherein by the application of economy producing factors, old plants may obtain an effectiveness in operation which compares favorably with the most modern plants.

Such a course is practical because the capital outlay involved is small. ELESCO Superheaters are a modernizing factor because their cost of installation is paid for in a few months in the saving they effect in fuel.

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Transportation Bldg., Montreal.
Please send me your Bulletin NT-5.
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Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all purposes.

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POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 1103 Union Trust Building

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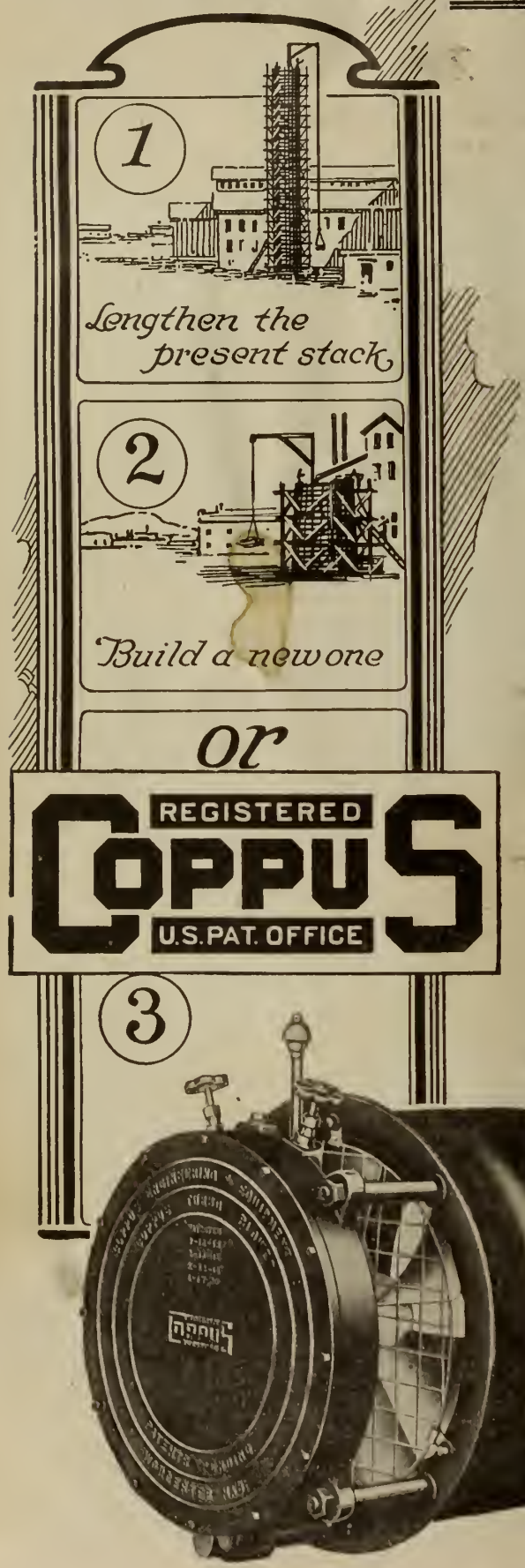
For Better Draft—

Which of the three will you select?



1. **Will you lengthen the old chimney with its ever-present element of danger, dirt, confusion—and high cost of labor and material?**
2. **Will you construct an entirely new chimney with its greater cost, loss of time and accumulation of building material, or—**
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THE COPPUS Turbo Blower can be installed in a few hours' time. It is low in cost, compact, easily installed, and gives positive control of your draft regardless of atmospheric or fuel conditions.

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The COPPUS catalogue tells an interesting story of better draft conditions. We shall be glad to mail it to you.

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This turbine driven boiler feed pump, built as a single unit, supplies a continuous flow of water without pulsation or vibration.

No valves to be reground, no water plungers or steam pistons to be repacked, no complicated governing devices to be adjusted.

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We build Heating Boilers up to 72" x 16', Return Tubular Boilers for power use, up to 165 H.-P.; settings, single or battery, in brick or all-steel.

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1	54 x 14	Horizontal
2	60 x 14	"
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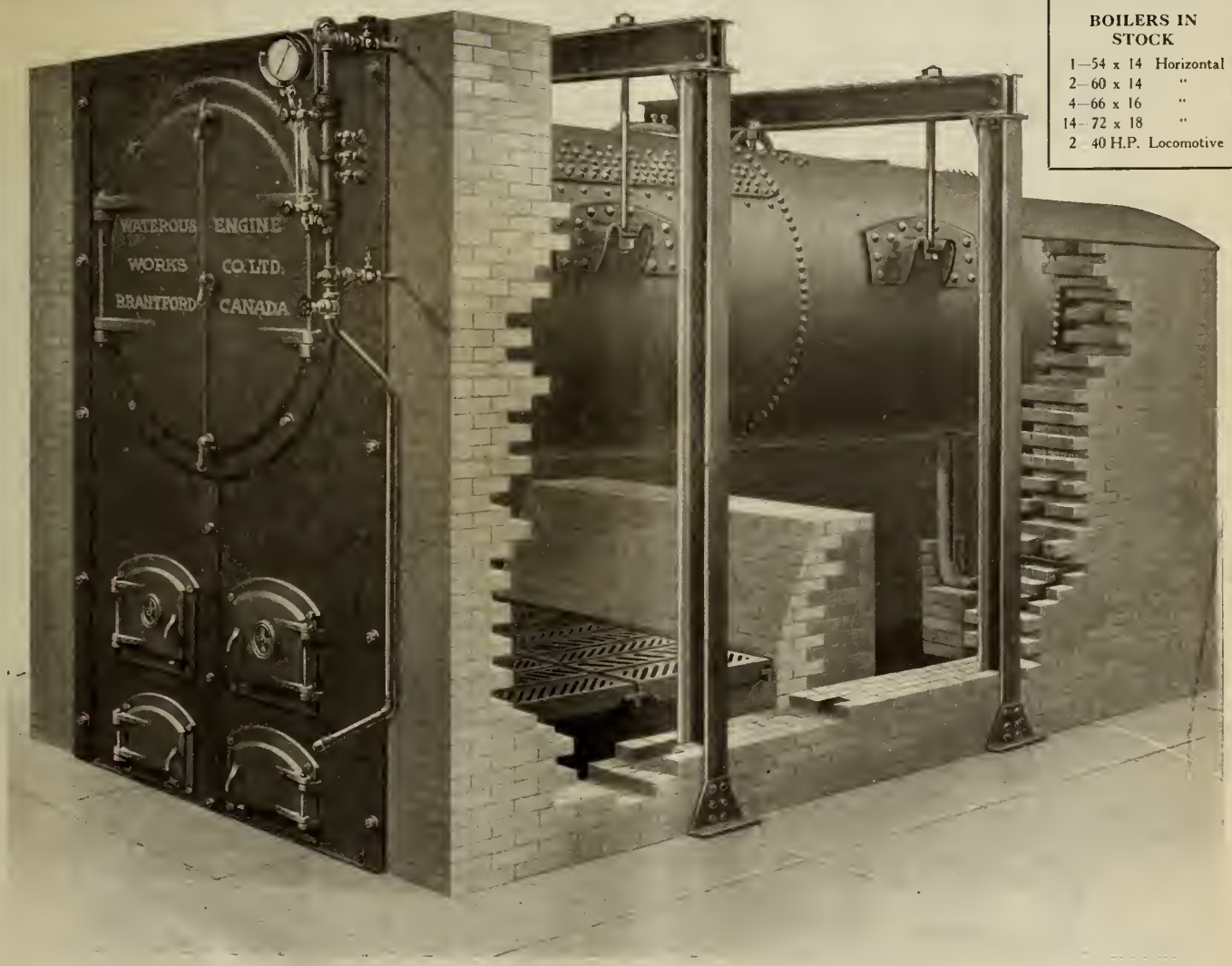
14	72 x 18	"
2	40 H.P.	Locomotive



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Brickyard Equipment

Nonpareil Grates are guaranteed to save at least 10 per cent. of your present coal bills. Made in all sizes.

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They fulfill a similar function because they save your money for you. The best preventative for wasted coal, ashes, clinkers, soot, etc.

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Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

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What's in a Name?

In buying NEW and USED Power Plant Equipment it is much to your advantage to say

PETRIE

Quality—Service—Satisfaction; that is what we guarantee on

Tanks—any size, any capacity up to 2,450 gals.
Vertical Boilers—1 to 75 H.P.
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Write for full particulars.

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That's the answer in a single word—a word that has come to mean much to power plant superintendents and other large buyers of renewable fuses.

For it is because Trico Renewable Cartridge Fuses are **powder-filled** that they reduce blow-outs 80%, save four-fifths of the money spent for renewal links and keep men and machines busy four-fifths of the time they were previously idle on account of fuse renewals.

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Fully Approved by
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Write us on your business letterhead for a test fuse of the capacity you use most. Try it out and judge for yourself.

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If you knew what we know, you would use them.

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA
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Strength; Goodness; Quality — these features distinguish Durabla Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed Product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

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DURABLA

We make all the necessary valves, fittings and piping to take care of high pressure superheated steam and high or low pressure saturated steam.

We can supply fabricated pipe work for any pressure or temperature which can be generated by any practical steam producing units.

CRANE POWER PLANT EQUIPMENT

is designed with the object of producing an efficient system having the longest possible life, the least liability of a break-down, and a minimum cost of up-keep.

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13

BOWSER
ESTABLISHED 1885

Gives Long Life to Machinery

Good Lubricating Oil, carelessly stored and inefficiently handled, causes more expensive and less efficient lubrication than does ordinary oil, properly stored, and handled according to modern systems of economy.

A Bowser Stream Feed Circulating and Filtration System will solve your problem and give long life to your machinery. Bowser will also cut your fuel costs. Extensive surveys show average savings in fuel costs of five per cent. where stream feed lubrication is in use as compared with hand lubrication methods.

There is a Bowser Circulating and Filtration System for *your* purpose.

Write for illustrated literature

S. F. Bowser Company Limited

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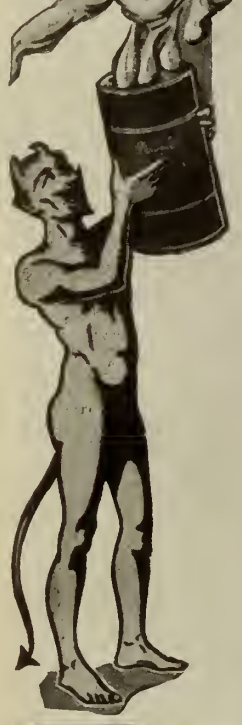
ONE-PIECE
Heat-resisting Furnace Lining
that gives Guaranteed Service

DEVIL'S PUTTY



Plastic, yet when properly baked and vitrified Plibrico—Devil's Putty — shaped into walls, baffles or arches makes one-piece, heat-resisting fire brick as strong as rock and impervious to heat.

Destruction of boiler settings always starts in the joints. Mortar falls out and clinkers find a splendid vacancy to fill. They fuse to the brick ends and when broken off take part of the brick with them. Patchwork repairs are necessary and frequent until finally a new setting is demanded.

PLIBRICO JOINTLESS FURNACE LINING

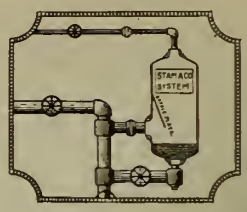
settings eliminate all this trouble. No mortar to fall out—no crevices to disintegrate. PLIBRICO withstands temperature up to 3100° F. Its smooth, jointless surface leaves no place for clinkers to lodge.

If your furnace does not give service it was not lined with PLIBRICO.

PLIBRICO is sold only in large steel containers of distinctive appearance as shown below. Warehouse stocks carried in Montreal, Toronto, Winnipeg, Vancouver and Calgary. Building the setting is a quick and simple task. Our interesting booklet L3 tells just how to do it. Write for a copy to-day.

JOINTLESS FIRE BRICK CO.
1142 CLAY ST., CHICAGO, ILL.

THE STAMACO SYSTEM



Blow-down of boilers is considered a big loss.

Stamaco eliminates blowing down, thereby creates a saving.

Do you realize that every time your engineer blows down your boiler, that 8% to 12% of fuel is wasted?

Stamaco is guaranteed to save fuel and labor and keep your boiler automatically and continuously clean.

Further details on application.

Sales Agents for Plibrico Jointless Firebrick

STAMACO THE SYSTEM THAT SAVES

Beveridge Supply Co., Ltd.
Successors to
Mill Supply Dept.
Beveridge Paper Co., Limited
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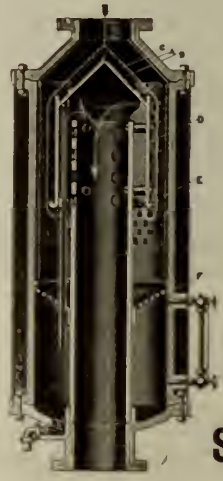
III IMPORTANT THINGS
TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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DIRECT SEPARATOR COMPANY
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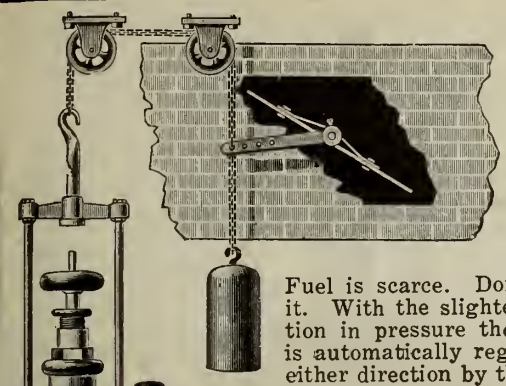
General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1921 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

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Thermometers Now Repaired in Canada

Prompt
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Competent instrument makers, ample equipment for overhauling and testing, indicating, recording and controlling temperature instruments, pyrometers, barometers, etc.

We would be pleased to receive visits and inquiries from those interested either in new equipment or repairs.

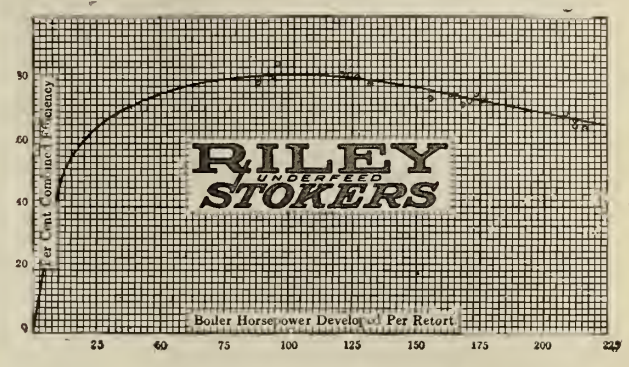
Taylor Instrument Companies

110-112 Church St., Toronto

There's a Tycos and Taylor Temperature Instrument for Every Purpose

753

ARE YOU WASTING COAL?



If your boilers are operating at 65% efficiency, whereas you ought to be getting 75% or 80%, then you should investigate to-day the possibilities of RILEY UNDERFEED STOKERS.

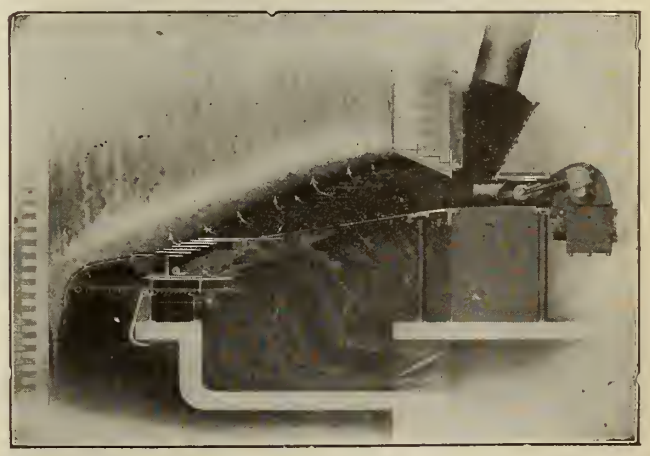
The first year after installing Riley Stokers, the Haverhill Boxboard Company saved ten tons of coal a day, and reduced their operating force by thirty-six men—a total saving of $52,000.00.

Our catalog shows a cut of an evaporation curve. From it you can figure just what you can actually save in dollars and cents by increasing your efficiency.

Catalog HR-6 sent on request.

For information on Murphy Automatic Furnaces for small boilers, see May 20 advertisement, or send for Murphy Furnace Catalog HM-6.

Sanford Riley Stoker Co.
Worcester, Mass.



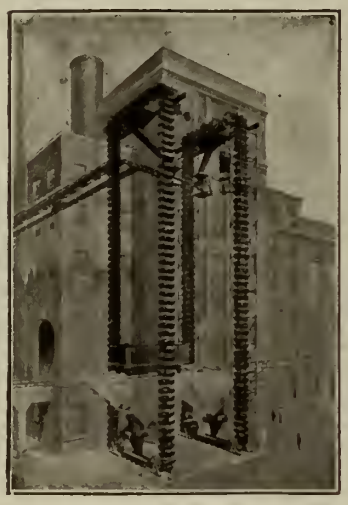
"MEAD-MORRISON"

CANADIAN MM

CANADIAN MM

Material Handling Installations for Power Houses

Made in Canada



Skeleton cut showing typical installation of McCaslin bucket conveyors as used for Power Houses.

Coal cars dump into track hoppers, which feed into conveyors carrying the fuel to the boilers.

Capacities--960--8,000 cubic feet per hour.

HOISTING MACHINERY
GRAB BUCKETS
CONVEYING MACHINERY

AGENTS:

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CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

The Heart of Your Power Plant

is the boiler room and there's where all efforts to cut down factory costs must begin. And that is also the place and the reason why you should use

BETSON'S

REG. U.S. TRADE MARK PAT. OFF.

PLASTIC FIRE BRICK

the one-piece furnace wall lining and brickless arch material.

Line your furnace with Betson's Plastic Fire-Brick instead of old-fashioned brickwork which invariably cracks and crumbles and lets in cold air. Then your walls will endure for years rather than a few months; and they'll be free from leaks and cracks, a seal against cooling currents of air.

Boiler arches, too, are readily constructed over simple, temporary sheet metal forms, and after a few hours' heating are all set for regular service. All in one-piece, no bricks to loosen and drop down, they hug the boiler closely as no brick arch ever could.

Betson's Plastic Fire-Brick assures an ideal furnace wall construction, which almost any workman can handle. It means practically a permanent freedom from furnace repairs. Look into it, lay in a supply of Betson's and prevent future boiler shut-downs.

Let us send you our instructive pamphlet about modern furnace wall construction as made possible by Betson's Plastic Fire-Brick. Just drop us a line to-day.

Betson Plastic Fire-Brick Co., Inc.
P.O. Box 386-6, ROME, N.Y.
Warehouses in Principal Cities

Canadian Distributors:
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44-6 Lombard St., Toronto, Ont., Canada

"If it isn't Betson's, it isn't Plastic Fire-Brick"

Which Stoker?

—You Make this Decision Once—It Must be Right

EXPERIMENT with any equipment is costly—but experiment with mechanical stokers is out of the question. The investment is large; it is made once in a lifetime; snap judgment won't do—**which stoker?**

Canadian plants want greater boiler capacity—continuous power day and night when necessary—they want this accompanied by greater economy in burning Canadian coals and by lower labor costs.

This means **high-duty stoker firing,** best exemplified by the Jones "A-C" (Automatic-Cleaning) Stoker.

Regardless of the size of the plant, the grade of coal burned or the local conditions to be met, the logical, safe answer to **"which stoker?"** is Jones "A-C."

The new "A-C" Catalog goes into detail. Jones engineers, with unmatched experience in this specialized field, will gladly make a survey of your plant and give you the full benefit of the best they have learned in installing stokers in many prominent power houses. Investigation implies no obligation.

The Canadian Stoker

Jones Stokers are made in Canada by Canadians, and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized, and the reorganization makes available for Canadian power users the extensive engineering resources of the Under-Feed Stoker Co. of America.

The UNDER-FEED STOKER CO., of Canada, Limited
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Quebec and the Maritime Provinces: The Cleaton Co., (Canada) Limited 403 Southam Bldg., 128 Bleury St., Montreal, Que.

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JONES "A-C" STOKERS

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Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

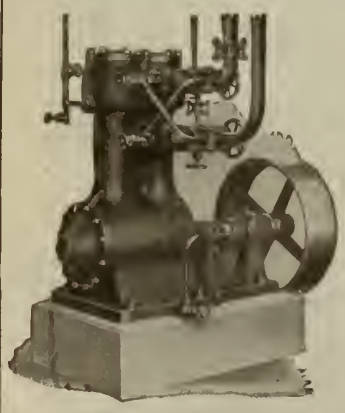
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

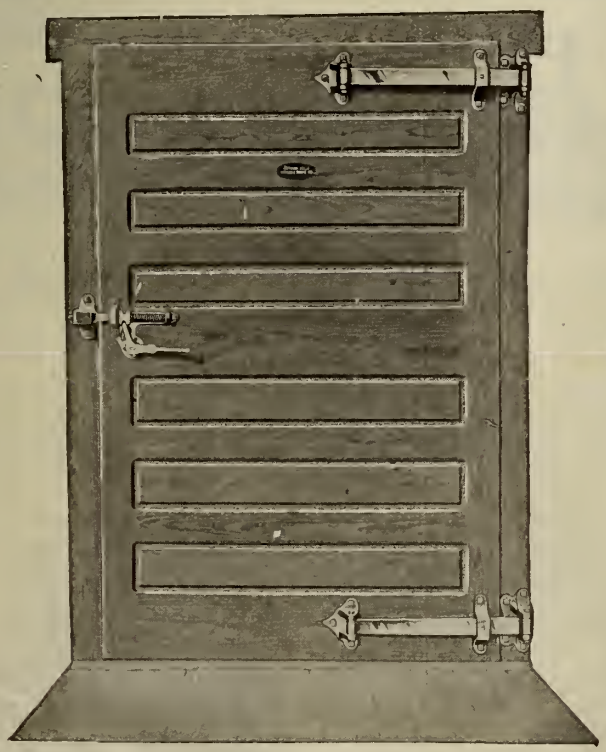
Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers -- also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

QUALITY YORK SERVICE

York Semi-Enclosed Refrigerating Machines

The Raw Water Ice Plant is rapidly taking the lead, and its development demands an Ammonia Compressor that is most economical in Power Consumption.

Where electric current is available at a reasonable cost, our Semi-Enclosed Machine, with direct motor mounting, makes a neat, clean and highly economical plant—no belts, no engine or steam lines.

The machine occupies a comparatively small floor space.

All the power developed by the motor is delivered to the crank-shaft of the machine.

These machines are built in sizes from 30 tons refrigerating capacity upwards.

Prices and complete information on application

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(Ice Making and Refrigerating Machinery Exclusively)
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P&H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs. the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

For all High Pressure service, and where it is objectionable to reduce the thickness of the wall of the pipe by threading, we recommend P&H Lap Joint.

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100 CHURCH STREET, TORONTO, ONT.

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

WE ARE SPECIALISTS

We have patent bending machines capable of bending steel tubing or pipe up to 6" by a cold process.

TUBE & PIPE BENDING CO. OF ONTARIO, LTD.

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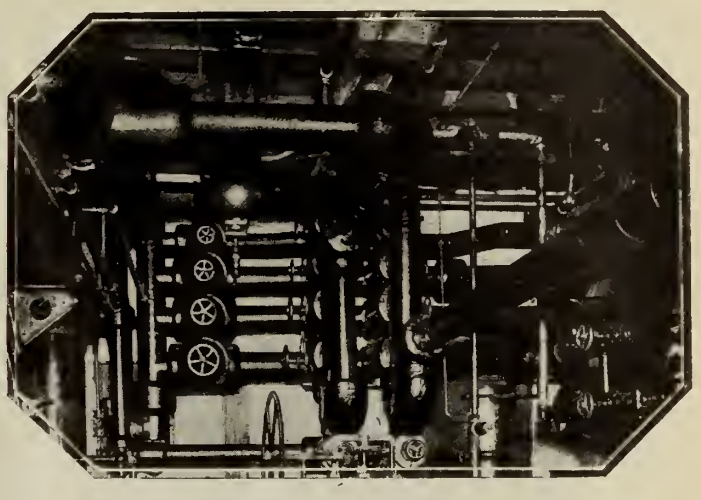

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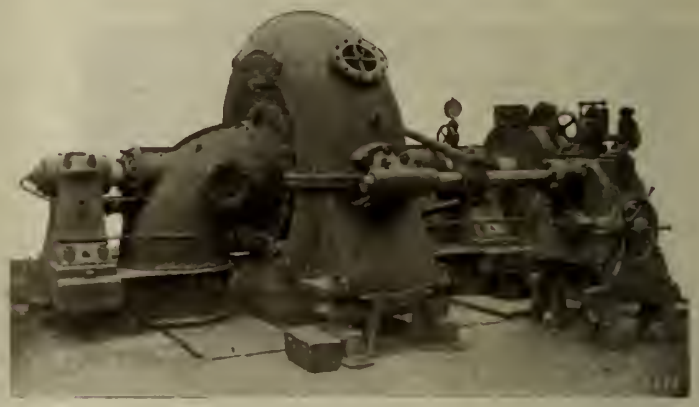

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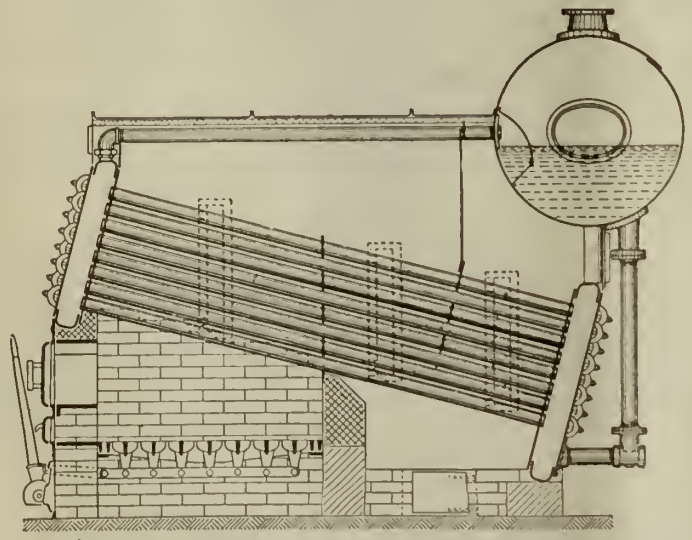

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New Truths and Old Fallacies

Hardness of Alloys—*Continued*

Charpy says that a lead-antimony-tin alloy is superior to a lead-antimony alloy, as tin strengthens the eutectic, but as to whether this adds to the malleability as well as to the hardness, we do not know.

Another hardening medium now being used to some extent is Metallic Sodium.

A mixture of lead, said to contain only 2 per cent. Metallic Sodium, is being offered as a substitute for babbitt.

Our experience with this element is that it is highly volatile and oxidizable and it is said to be very unstable. As a protection against the heavy fumes, this mixture has to be made in a closed kettle and the metallic sodium held beneath the molten lead to prevent its dissipation and oxidation from atmospheric influences. It is also claimed that chemical action takes place, which changes mixture to an oxalate of lead, particularly if exposed and that the men handling it have to be specially instructed in its use and protected from the fumes.

We understand that it cannot be used over again, to advantage, that its value is lessened as scrap, and that it cracks from shrinkage unless secured by dovetail recesses close together and is difficult to pour a casting free of blowholes; also that the U.S. Government found it unsatisfactory.

The compression test figures shown herein do not inspire confidence in copper as a hardening medium, nor in the belief that tin base metals have any preponderable superiority in that respect over lead base metals. Were it not for the slightly superior malleability of Genuine Babbitt, there would be no valid reason for its use at all and from the beginning it has been displaced by Magnolia in bearings of all descriptions, where the use of Genuine had been deemed imperative.

(Continued next month).

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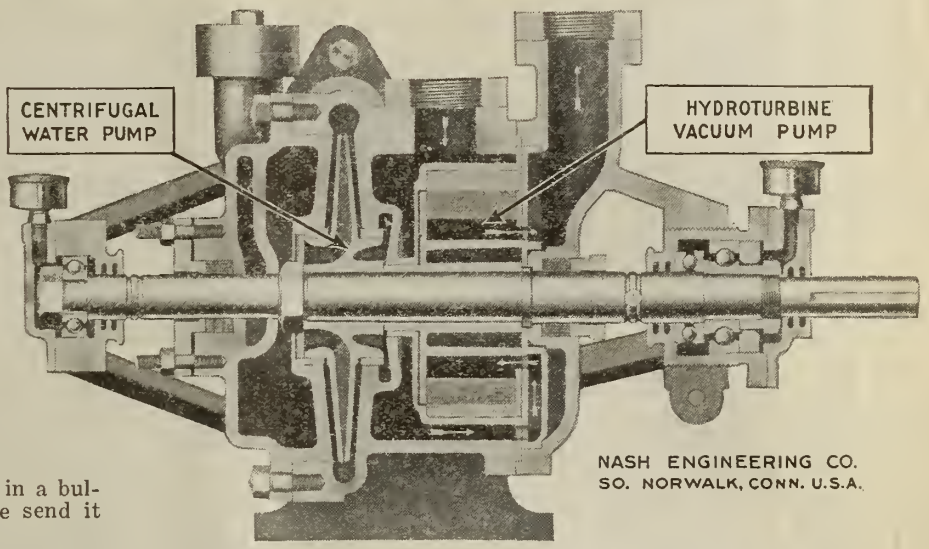
Full details of construction are given in a bulletin devoted to this pump. Shall we send it to you?



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The Power Plant Journal of Canada

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Established 1907
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Overhauling and Adjusting in the Engine Room

In This Article the Subject of Pumps is Carried Further, and General Construction of the Water End and the Method of Packing Explained

By "FITTER"

IN cases where the seats of valves in the water end of pumps require some facing up, which is not enough to necessitate taking out the individual seats or the deck, they can be faced in place. If the valves are of brass the best way is to mount the valve on a temporary spindle and grind valve and seat to each other with powdered emery. When the valve seats only are brass, an iron plate of the same size as the valve can be used. This plate can be mounted on a spindle and is of course faced up in a lathe. The brass being softer than the iron will of course wear down to a face without injuring the iron plate. A correspondent in this issue mentions facing valve seats down with a piece of smooth file, finishing off with a file ground to a scraper edge. If a man is trained in the efficient use of a scraper he can face the seats up by this means alone, but unless he has good experience with using a scraper he may likely make the last state worse than the first. With flexible rubber valves, there is a good deal of leeway permissible from a perfect face on the valve seat.

Pumps fitted with special types of valves, such as the Kinghorn valve used in the "Weir" pump, or some types of air pumps, generally give little trouble as far as the seats are concerned, and when the discs themselves show signs of wear are easily replaced. These valves are simply flat discs of thin bronze of special composition, mounted one above the other on the valve spindle, with the lower disc the same size as the seat and the next one somewhat smaller, while the top one is smaller again. Owing to their lightness and the fact that a certain amount of water gets between them to act as a cushion, they work with very little shock, and last as a rule much longer than the ordinary kind of valve.

The Piston or Plunger Pump

Reciprocating pumps are divided into two general classes, inside and outside packed pumps. The inside packed pumps are the piston type, while the outside packed are the plunger type. Occasionally one finds a pump which is a combination of inside and outside packed, that is a piston plunger pump, but there are not many of these kind knocking about nowadays. They used to be rather plentiful in certain classes of marine jobs, but I have not come across any in stationary practice.

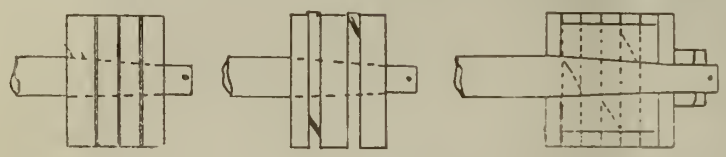
The piston pump has in most cases a packed piston, that is a piston made up of a main body with flange cast on it, and a follower plate which holds the soft packing in place. Sometimes a piston pump is made without any packing, the piston being made to fit the liner closely, and water tightness being secured by turning narrow grooves in the body of the piston, which form a water seal. In other types, rings of special composition are fitted in the piston in the same way that the spring rings are fitted in the steam piston, and this is a very satisfactory construction. The plunger pump has no packing at all excepting that in the gland through which it works at the front end of the pump, and this is the easiest type to pack. We will just go over the work connected with these different types and see where the advantage or disadvantage of either lies. Engineers differ considerably in their opinions on these points, and as in many other engineering matters, it largely depends on the individual experience one has had which way the preference is likely to go.

The Water Piston

In the usual type of piston pump, the piston works in a brass liner which is fitted into the barrel of the pump a tight fit, usually known as a drawing fit. That is, it is usually forced to its place by being drawn down with a plate and long screw as shown in the sketch, and removed in the same manner. In order to make it absolutely secure, a ring is fastened over the mouth of the liner by a number of set screws, a water-tight joint being made between the liner end and the ring. It is essential that the liner be a tight fit in the barrel of the pump, otherwise water will be passed from one end of the liner to the other between the pump casting and liner and a loss of efficiency result. This is not a very common occurrence, but I have known it to happen when a new liner has been fitted to a pump by careless machinists. When having repairs made by the machine shop for any part of the engine room machinery, always give it your personal attention. There is a real necessity for this, especially when the machine shop is in your own factory. They are apt to look on engine room work as something to be got rid of as soon as possible, and if not carefully watched and impressed with the importance of the part being made right, will not give it the care that they will when making a jig or tool for production purposes. Further, and perhaps the main reason for any carelessness on their part, is the fact that they in very rare cases have any realization of the importance of the duties the piece may have to perform, and the troubles that may ensue to the operating force in the engine room. Therefore don't take anything on trust as far as the machine shop is concerned.

The body of the piston is fitted on to the piston rod, which is usually of brass or bronze composition, a taper fit, with a shoulder at the end of the taper in the beter made type of pump. This body may be solid, as in the smaller sizes, or hollow with ribs supporting the spider on which the packing is fitted. The piston rod extends through the body of the piston far enough to give support to the follower plate which holds the packing in position, and for the nut and jam nut which holds the whole together and on to the rod. The packing is as a rule a square fibre packing, of which there are a number of good brands on the market.

The method of packing will depend on the engineer, there being two ways. One of these is to take the packing, scarfing one end so that it will lie square up against the flange, and wind it round and round the body of the piston till the packing space is filled up, the back end being again scarfed to fit square up against the follower plate. The second method consists of cutting one ring at a time, and either scarfing the ends or butting them, leaving a small opening for expansion. Both these methods have their exponents, but personally I prefer the single ring method. When the packing is laid on the piston in a continuous spiral, it forms a solid and compact mass when tightened up, and there is no opportunity for any give or adjustment. This is the feature that those who use this method claim is an advantage. However. it allows no chance for the packing to expand, and therefore puts a severe strain on the packing itself, and also makes the friction on the liner much more severe, without gaining anything in water tightness. There is another disadvantage and that is that when any wear occurs the whole of the packing must be taken off and replaced.



Types of Pistons

If the packing is laid on ring by ring, staggering the joints and leaving about one-eighth to three-eighths between the butts acording to the size of the pump and the known tendencies of the packing, there is a chance for a little adjustment all round when the pump is working. A certain amount of water can find its way into the packing space and act as a lubricant. The spaces between the butts allow room for expansion, and there is less friction. This makes for longer life to begin with, and as it is the end rings that get the worst of the wear, these can be replaced without taking the middle rings out, and after a while they can be used to replace the middle rings, new rings being put in the place of the end ones. This tends to cheapen packing expenses.

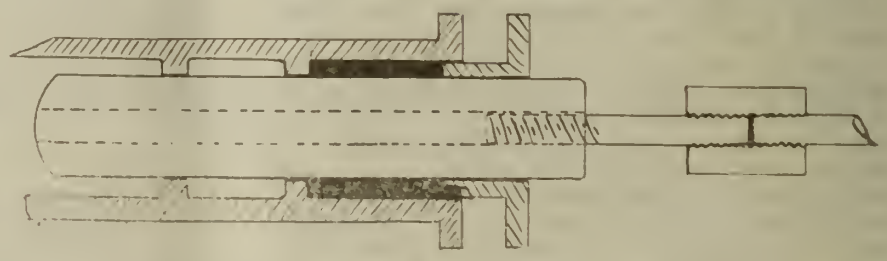
With every pump there is furnished a box spanner for the purpose of taking off and tightening up the piston rod nuts. This spanner should be carefully preserved and used for nothing else but that pump, and nothing else should be used on the piston rod nuts but the spanner made for the job. Too often, one finds, when the cover is removed from the water end, that the piston is held on to the rod by two shapeless pieces of metal, hammered and battered out of all semblance to the nuts they once were, and only capable of being removed by a further application of the hammer and caulking tool or chisel. There is no need of this. It is easier to use the tool made for the job, and if there is any difficulty in slacking off the jam nut without moving the two nuts together, hold the inside nut with a crow-foot spanner or a flat spanner offset to go inside the box spanner. Don't slack the two nuts off together, as in doing so you run a good chance of hurting the thread or even twisting off the end of the rod. A little care in this direction will save a lot of time when overhauling is necessary, and if you ever have to do a job of packing in a hurry, you will be glad you took care of the nuts and spanners.

When starting the first turn of packing always put it under the piston first, as this will lift the piston up into the centre of the liner. If the packing is put in the top first, and the piston is lying down in the bottom as it is most likely to be, this makes it all the more difficult to get the packing round. After the first turn is on it will of course not matter which position the second ring is introduced in.

When actually putting the packing on the piston, make sure that each individual turn, or each individual ring, goes hard up against the flange, first, and against each other after the first one is in. Tap them up all round a little at a time, till you know by the feel of the packing stick when you strike it that the ring is solid. Don't stick it in anyhow because you are in a hurry. In doing any job on a piece of apparatus that has to be opened up and closed up again before it is ready to work, remember that the more haste the less speed. Don't waste time, but don't try to save it by scamping the job, because if you do you will have to do it over again. You young engineers just starting up the ladder will find that when the chief discovers a man whose work he can rely on, that man will not be long before he works up. No chief likes to have a man whom he has to watch or who will report a job done when it is only half done. He has generally enough to occupy his mind without having to watch every turn of packing that goes in or every nut that is tightened up. This may sound like preaching, but there are quite a few gray hairs in my head caused by subordinates who assured me they had done a good job, when in their hearts they knew they had not.

When all the packing is in, put on the follower plate, and tighten up the nuts. In small pumps the follower plate is merely held by the nut that holds the piston on to the rod, but in larger pumps the follower plate is held by set screws screwed into the body of the piston. In any case, tighten up the follower plate to its working position, but before you put the jam nuts on the rod make sure that your piston is not too tight in the liner. You should be able to move the piston up and down in the liner the full length of its stroke by means of a bar, without undue effort. A small pump of say four inches bore should be moved easily with a bar 18 inches or two feet in length, while the large sizes will require more leverage. However, pumps up to twelve inches should move easily with a bar not more than four feet long. Of course, this refers to horizontal pumps. If the piston does not move fairly easily, then make sure what is holding it. If the packing is doing it, find out if there is too much in, and if so it may be necessary to use more rings of a slightly smaller diameter, or cut the end ring in two lengthwise to make it narrower. Don't run a pump with the packing too tight, for it will only cause undue wear, and you will have to repack it so much sooner, besides putting an extra strain on rods and all working parts. Remember that most packing swells to some extent until it is saturated, and if you start with the packing unduly tight it is going to be worse after a while. On the other hand, don't have it too slack or it will flop about and rub on itself, causing just as much wear as if it was too tight.

With the solid type of piston there is of course no question of packing. The only thing to do when this piston gets worn or, as usually happens, the liner gets worn is to bore the liner out and fit a new piston. However, I have seen a temporary repair on a piston of this kind that lasted so well that it was made practically a permanent job. This was a small duplex vertical pump, with solid pistons, having two water grooves turned in each. These had in course of time worn slack, and as there was no chance of replacing them immediately, some means of keeping the pump going in a fair state of efficiency was necessary.



Section of Plunger Pump

The method adopted was to turn the water grooves deeper and wider, and to fill them up with white metal, leaving the metal projecting above the surface of the piston. This was done in the ordinary way of making a mold and pouring the metal in. The rings were then scraped up to fit the bore of the liner, and the job was so successful that the white metal was worn down and refilled several times before the pump was fitted with new pistons.

In the case of pistons fitted with rings, whether composition or otherwise, the usual way of effecting a repair when the proper rings are not available is to make rings out of Muntz metal or other suitable bronze. A sheet of ½-inch Muntz metal is a useful thing to have around, and although in the case of a power plant situated close to a source of supply this might not be needed, in more or less isolated plants it often is.

A strip of metal is cut long enough to bend round in the form of a ring, and of course larger in diameter than the bore of the liner or cylinder. It is scarfed at the ends in the ordinary way and fitted into the cylinder just as a cast iron ring would be. This is not by any means an unusual thing, and I have seen steam piston rings made in the same way and serve their purpose for quite a while. Of course, one would expect in a stationary plant that spare rings would be on hand, so that there would be no necessity of making temporary expedients, but there is no harm in knowing that it can be done.

The Plunger

Coming now to the outside packed or plunger type of pump, we find quite a different method of construction. Here we have no packing inside the water cylinder at all, and no liner such as we have in the piston pump. Instead, all we have is a narrow ring of metal in which the plunger slides, and at the outer end a stuffing box and gland to take the soft packing. The weight of the plunger is carried on the packing in this gland for the most part. The packing being entirely outside the cylinder gives the pump its description of outside packed. Practically the only trouble with these pumps is the wearing of the packing and the plungers themselves. Packing is easily renewed. The plungers are connected to the piston rod by a crosshead into which they are screwed and held by nuts. The pumps are made in simplex and duplex styles, and are either end packed or centre packed. The plungers are of course single acting, so that there must be two plungers in separate barrels to give continuous delivery. These cylinders are arranged either with their ends abutting and the plungers working out at opposite ends, or with the cylinders facing each other and the plungers made in one piece for both barrels. In the first case the plunger farthest away from the steam piston is worked by extension rods from the crosshead of the inside plunger. In the latter type the piston rod is continued through a small stuffing box and is screwed into the plunger, which of course is one piece. There is one advantage about the outside packed pump and that is that there are few moving parts, the packing is easily got at, and the wear takes place on the packing only. On the other hand, the heavy plungers induce rapid wear on the packing, and some trouble is experienced with glands breaking through the construction being not well designed. These glands are usually only fitted with two studs, and as often happens the inside one is difficult to get at when the pump is working, the outside one gets all the tightening. This results in broken glands in many cases. The main thing to watch with an outside packed pump is to get a good grade of packing, pack the gland evenly, and repack it when the packing shows signs of wearing or getting hard. Don't try to stop a badly leaking gland when the pump is working and the packing is hard. It usually results in trouble. When the plungers wear they have to be renewed, and when they are renewed care must be taken that they are not made too heavy. If they are procured from the maker there will be no trouble about this, but if made by the factory shop or a local foundry they may be unduly heavy. Also take care if made locally that the core hole in the plunger is tightly plugged before the plunger is fitted. If water gets in there it will lead to a considerable addition to the weight of the plunger, as well as a lot of useless work for the pump.

We seem to have found quite a lot to say about pumps, but we have by no means exhausted the subject. Probably this will help to make the young engineer understand that it takes time to become an engineer, even if this term is only applied to a good practical man, leaving the theoretical end strictly alone.

(To be continued)

GRAPHITE

One of the non-metallic minerals with which the public is more intimate is graphite, otherwise known as plumbago or black lead. It is a soft, dark grey, opaque solid, of a greasy metallic lustre found in detached masses, beds, crystals and sheets. Ceylon is the chief source of the world's supply of graphite, but it is also produced in Canada, England, New Zealand, Siberia, Germany and the United States. In Canada it is found in Northern British Columbia, in Eastern Ontario, in Ottawa, Argenteuil and Pontiac counties in Quebec, in Carleton, Charlotte and St. John counties in New Brunswick, and in Cape Breton, Inverness and Halifax counties, Nova Scotia.

Graphite occurs usually in the fissures or veins of granitic or similar rocks, but is also found as isolated plates, patches and pockets in what are known as bedded veins. It is commonly associated with quartz, calcite and mica, according to the rocks in which the graphite occurs.

The crude graphite must be very finely ground, to detach it from associated minerals, after which, by a concentration process, it is separated from the accompanying mineral particles. It is very carefully graded, both as to fineness and purity, to eliminate particles of grit.

Graphite is best known through its use in the manufacture of lead pencils. For this purpose it is mixed with clay, moulded into shape and baked. The proportion of clay used regulates the hardness of the pencil. For pencil-making the best graphite is secured from Borrowdale, Cumberland, England, and Batugal, Siberia.

Other uses of graphite are in the manufacture of stove polishes, and paints for ironwork, of crucibles for the casting of metals, and of electrotypes. As a lubricant graphite is used, both in dry form and mixed with grease or oil, in many industries where heavy work and high speed are required. In foundries it is used in facing moulds to give smooth-finished castings. The electrical industry is using large amounts of graphite. and in the manufacture of gunpowder it is utilized as a moisture-proofing material.

Canada produced 2,227 tons of graphite in 1920, valued at $173,537, as against 1,360 tons in 1919, of a value of $100,-221. In 1920, Quebec contributed 233 tons and Ontario 1,994 tons, while in 1919 almost the entire output was from Ontario.—"Conservation."

DOMINION STEEL PRODUCTS COMPANY EXPANDING

The Dominion Steel Products Company, Limited, whose main office and factory is at Brantford, Canada, have just opened a sales branch at 418 St. James Street, Montreal, to handle Dominion light plants, as well as pulp and paper machinery, rolling mill equipment, Dominion chucks and other articles this company manufactures.

This company has just arranged to manufacture in Canada the well-known Darling valves and Darling fire hydrants.

Their new Montreal branch will be in charge of Mr. Maurice P. Shea, who has had many years' experience in the machinery, valve and engine business. Mr. Shea for four years was overseas in command of a submarine chaser.

AN ANONYMOUS CORRESPONDENT

We have received a letter of criticism from a correspondent who, however, has neglected to give any name or address. We shall be glad to receive these, not necessarily for publication, but as a guarantee of good faith. Anonymous letters are not entitled to any consideration, but genuine letters of criticism from readers will be published just as quickly as letters of commendation.

Power Plant Instruments and Meters

The Operating Engineer Now Has Available a Much Greater Number of Helpful Instruments Than His Predecessors—Some of Them Are Classified Here and Their Uses Explained

By E. G. BAILEY*

INSTRUMENTS and meters are used in the power plant to visualize operating conditions for the purpose of obtaining better efficiency and capacity.

In the past the question of capacity has been emphasized more strongly than has efficieney, and it is a matter of prime importance, for the man who maintains a high capacity with every piece of equipment in the power plant is doing the work with a smaller investment and a smaller overhead charge than the man who is letting the boilers and generating equipment drift along at a lower rate and a poorer load-factor.

While instruments and meters have been used extensively in power plants, they were largely confined to test work where they were in the hands of an experienced engineer who carefully calibrated and checked up all apparatus before and after the test. Such instruments were practically all indicating, and readings were taken at intervals of time throughout the test.

For a long time the operating engineer had nothing to visualize his operating conditions except a pressure gauge, a water glass, and the steam-engine indicator. Later, the ordinary thermometer came into general use, and a little later the recording pressure gauge and recording thermometer found their way into the power plant, and their use has been gradually extended until they are to-day very prominent as power-plant instruments, and are serving a good purpose in a variety of uses.

Classification of Instruments.—In comparatively recent years many additional instruments and meters have come into common use. These may be divided into three general classes:

1. Instruments to show condition (indicating and recording): (a) Pressure; (b) temperature; (c) humidity; (d) quantity.

2. Meters to indicate or record rate: (a) Steam flow; (b) water flow; (c) air flow; (d) stoker speed; (e) fuel supply.

3. Meters to show relation: (a) Steam flow, air flow, fuel supply; (b) energy input, work output, turbines, pumps, etc.

The instruments of the first class apply particularly to fluids and material, showing the state or condition of these. Pressure and temperature are the most common factors. Temperature, for instance, is a measure of heat potential showing the state of molecular activity. Pressure is a state of molecular compression. Quantity is used in a varied sense; for instance, a level gauge showing the amount of water in a boiler or the amount of coal in a bunker. Integrating meters which show the total quantity up to a certain time also belong to this class.

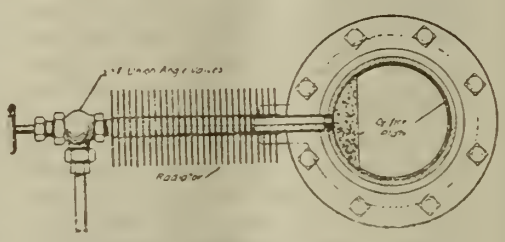


FIG. 2.

Meters which indicate or record rate are extremely useful in the power plant. We are all familiar with the rapid development that has been made since the venturi meter was first used as a means of measuring feed-water. Later forms of flow meters have been developed for measuring steam, gases, oil, etc.

The third item, covering meters which show relation, is the most recent and most important development. The first two classes of instruments and meters give results that are as a rule of limited value until they are associated or compared with certain other results. For instance, a boiler may be generating a great deal of steam but doing it very inefficiently with a high flue-gas temperature. It is therefore desirable to correlate certain factors which are properly associated so that the operating engineer can see whether or not the best operating conditions are being maintained.

Indicating v. Recording Instruments.—The question of installing indicating rather than recording instruments is one which most frequently comes up for decision. It has usually been considered that the recorder had its principal advantage in showing the chief engineer or boss what was taking place throughout every hour of the day or night. This is a distinct advantage, and is sufficient to decide the matter in most cases. There is also the further advantage that a great deal of valuable information can be obtained from different types of meters and working out therefrom important engineering data. The principal advantage of recording meters over those which indicate only, lies in the fact that the fireman or the operating man has the chart record before him at all times, enabling him to note whether or not he is maintaining uniform conditions. Recording instruments show in what direction and at what rate conditions are changing, and, for this reason alone, recording instruments have a decided advantage over those which are indicating only.

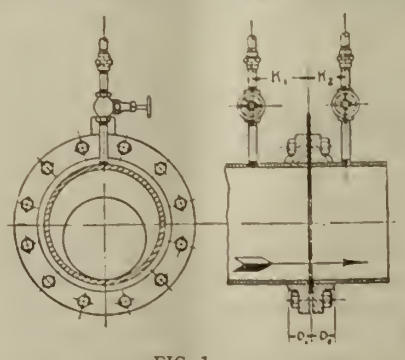


FIG. 1.

Accuracy and Care of Instruments.—One of the first and most important points to be considered in connection with instruments and meters is their initial accuracy and their reliability in maintaining this accuracy. Unless the readings are reasonably accurate they are worthless.

Many instruments and meters installed in power plants have been of little or no value because the operating engineer failed to give them proper attention. The operating engineers who do not produce value from instruments and meters may be divided into three classes:

First, the man who is entirely unfamiliar with meters and instruments and who is afraid to touch them for fear he might damage them. Second, the one who fears nothing of this kind and does not hesitate to take any instrument entirely apart without reading instructions. Third, the one who is too busy to pay any attention to the instrument or meter. Often, in case of failure or inefficieney, a meter may be showing him exactly what is wrong with his plant, yet he is not sufficiently acquainted with its readings to interpret the results indicated.

The real solution is to place the power-plant instruments in the hands of somebody who is thoroughly familiar with them. The duties of this man are threefold: First, to make sure that the instruments are in proper adjustment. Second, to interpret correctly the readings and to instruct the fireman and operating engineer how to obtain the desired results. The third function of this "results engineer" is to calculate, plot and tabulate the results in such a form that he can keep a reliable check on all equipment so that he can recommend improvements.

There is a real field for such men, and their efforts are going to be appreciated by those who are controlling the financing of power plants and industry.

Flow Meters.—Of the second class of

meters, as also of the first, there is a very general knowledge to-day, but in regard to the orifice type of flow meters there are a few points that are not fully understood by all power-plant men. These it might be well to explain briefly.

The sharp-edged orifice has been calibrated and used a great deal for measuring water and air flowing from tanks and reservoirs, usually designed for high-pressure differentials. Its successful use in pipe lines was limited, however, to very low capacities, or, in other words, to cases where the ratio of orifice diameter was small. Those who first used the thin-plate orifice between a pair of pipe flanges for measuring flow of fluids at high velocity found very discordant results. Subsequent experiments have shown that this was due to the fact that a great deal depended upon where the pressure connections were made; the principle was the same as with the venturi tube.

Fig. 1 shows an orifice located in a

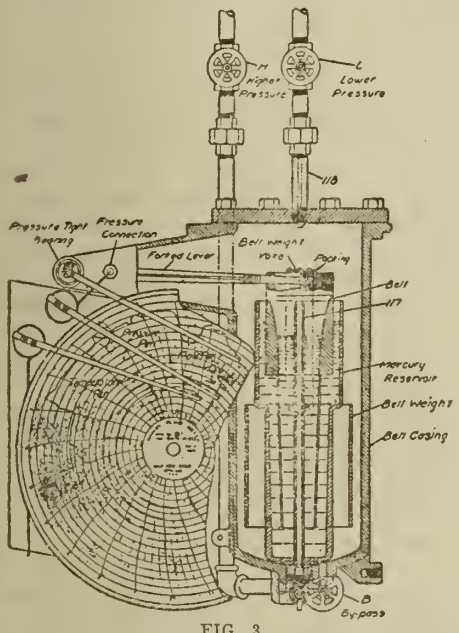


FIG. 3.

horizontal gas line. The opening is circular, but eccentric with regard to the pipe, so that the hole is flush with the bottom of the pipe with no chance for condensation to accumulate. The pressure connections are taken out from the top of the pipe, and may be connected to any form of indicating or recording meter.

A similar type of orifice is used for measuring dirty water, the connections being made from the side of the pipe instead of the top, in order to prevent accumulation of air pockets.

The orifice shown in Fig. 2 is segmented, having a narrow annular ring around the edge of the pipe, the dam or restricting portion being a segment immediately in front of the pressure connections. In the case of measuring steam the pressure-connection pipes are usually at the side so as to be free from accumulated air and also to form a reservoir for maintaining equal water level in the two connecting pipes. A radiator is supplied so that as soon as there is a displacement of water caused by the motion of the meter, steam is condensed to take its place and maintain equal water level in both pipes.

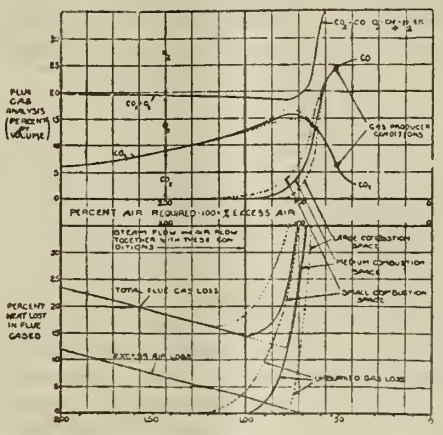

FLUE GAS ANALYSIS (PERCENT BY VOLUME)
CO
GAS PRODUCER CONDITIONS
PERCENT AIR REQUIRED-100=% EXCESS AIR
STEAM FLOW MEAN FLOW TOGETHER WITH THESE CONDITIONS
LARGE COMBUSTION SPACE
MEDIUM COMBUSTION SPACE
SMALL COMBUSTION SPACE
TOTAL FLUE GAS LOSS
PERCENT HEAT LOST IN FLUE GASES
EXCESS AIR LOSS
UNBURNED GAS LOSS

FIG. 4.

The orifice, as well as the pitot and venturi tube, produces a differential pressure proportional to the square of the velocity of the flowing fluids. The extremely small differential at the lower rates of flow makes it difficult to secure the desired accuracy over the lower ranges. For instance, the differential pressure is only 1 per cent. of the maximum when the rate of flow is 10 per cent. of the capacity of the meter.

Fig. 3 shows a specially shaped bell which is sealed in mercury, and weighted on the outside of the mercury reservoir so as to be submerged to the point of greatest diameter in the position of zero flow. The higher pressure from the inlet side of the orifice is connected through the centre pipe to the interior of the bell, while the lower pressure comes into the meter casing. When metering steam or water, the entire casing and connecting pipes are filled with condensed steam.

A slight differential pressure produced by the lower rates of flow introduces a force over the entire area of the bell, pushing it upward. As the bell rises to the position shown in the diagram, the differential pressure corresponding to the change in mercury level, within and without the bell, pushes the bell upward until the emerged volume of tbe walls of the bell equals the volume of mercury displaced in the interior. The shape of the bell is so designed that the motion is directly proportional to the rate of flow.

Meters to Show Relation.—The third class of meters showing the relation between different factors has been developed for the purpose of giving the power-plant operator the maximum amount of condensed net results directly.

In the case of combustion, to know merely the steam flow and the percentage of CO_2 is not sufficient, because it is very seldom that the highest percentage of CO_2 which can be obtained is that which should be striven for. Fig. 4 shows a diagram of gas analysis running from about 180 per cent. excess air to a deficiency of some 25 per cent. which represents producer gas conditions. It will be noted that the percentage of CO_2 falls off rapidly after the point of theoretical air supply is passed. In the case of furnaces having limited combustion space, CO_2 and unburned gases may start to form with an air excess of 60 per cent. and a CO_2 content of 11 or 12 per cent. In this case the most economical condition of fuel bed would be one which would produce these results while giving neither more excess air nor much unburned gas. The average of the better modern practice is shown in this diagram as the one corresponding to medium combustion space where the excess air can be reduced to 40 per cent. above the theoretical before the unburned gas is formed to any appreciable extent. This corresponds to about 13 per cent. of CO_2. It is obvious from the diagram that the combustion should be maintained at this point.

Under these ideal operating conditions a definite amount of air is required to support combustion. We may, therefore, speak of the heat produced per pound of air. This heat is capable of generating a certain amount of steam. We may therefore compare the amount of steam produced with the amount of air used for combustion and obtain a very reliable indication of the efficiency of the combustion.

This has been accomplished by a meter which records the steam output from the boiler reading directly in percentage, and also records the rate of air flow through the boiler passes.

Other types of meters belonging to this class include the rate of stoker speed, as well as steam flow and air flow, the latter being adjustable according to the evaporation per pound of coal, so that stoker speed readings should be synchronous with the steam and air flow, as long as the coal is being burned at the proper rate to carry the load.

PAPER ON FIRE CLAY MORTAR

A very interesting paper has recently been prepared by Raymond M. Howe, M.A., on the subject of "The necessity for care in the preparation and use of fire clay mortar."

It is a well-known fact, states the author that various materials, when added to fire clay either decrease or increase its refractoriness. Often these materials are added in order to cause the fire clay to set in the cold and their depressing effect on the refractoriness of the mortar is not generally comprehended. The paper is really designed to show, 1—the effect of such additions; 2—the possibility of improving the quality of refractory mortars through the addition of finely ground bats to fire clay; and third, the desirability of using thin joints.

Various tables are shown, also illustrations of effects of treatment on the bricks. The Elk Fire Brick Co., Ltd., Hamilton, Ont., who called our attention to this paper, state that they have a

Some Points in Boiler and Furnace Design*

Determining Whether an Economizer Will Pay—Brickwork In Furnace Design—Effect of Radiant Heat—Percentage of Rating For Economical Operation—Difficulties Encountered From Slag—How to Reduce Clinker Trouble

By DR. D. S. JACOBUS

TO approach perfection from a thermal viewpoint, a boiler and superheater, including its economizer and air heater, if used, should absorb a maximum amount of heat with a minimum draft drop. There are commercial elements entering into the problem that limit the application of this principle, and so many variables that each case must be considered by itself in order to arrive at the best arrangement. A relatively large amount of boiler-heating surface, with large flow spaces for the gases, if properly insulated to prevent undue radiation, would more nearly meet the requirements of absorbing a maximum amount of heat from a given weight of fuel burned with a minimum draft drop than a smaller amount of surface, although the latter would in most cases be preferable from a commercial point of view. Adding an economizer will ordinarily add to the thermal efficiency; the same applies to an air heater, but here again, on considering the commercial side, it may be found that the character of the load and the class of operation and fuel conditions are such that it will not pay to install an economizer or an air heater.

Determining Whether an Economizer Will Pay

In determining whether it will pay to use economizers in a new plant, the problem should not be approached by comparing the efficiency of a boiler with that of the same boiler with an economizer added to it. The proper way is to compare the results to be expected from boilers best suited for the service without the addition of economizers to those to be expected for the best combination of boilers and economizers.

It will sometimes be found for exceptional load conditions that a larger boiler properly designed and baffled will give better commercial returns, all features considered, than a smaller boiler with an economizer—or, for that matter, for any boiler that can be selected with an economizer. In the case of an old plant the question of whether it will pay to add economizers to the boiler is a more simple one to answer than for a new plant, as the added efficiency due to the economizers may be readily computed on the basis of the known flue-gas temperatures, gas weights, etc.; but here again the load conditions must be taken into account, as well as the fact that there will be an increased cost of upkeep and added complication through the necessity of installing an induced-draft apparatus.

For peak load service it does not usually pay to install economizers on all boilers. A good arrangement may be secured for some classes of service by adding economizers to, say, one-third of the boilers, operating them at a more nearly uniform load than the rest and cutting in those that have no economizers during the peak-load periods.

Another case where it does not pay to apply economizers is where boilers are used for stand-by service. The cost of fuel is a governing factor, and because of the increase in fuel costs during the last few years we are approaching more closely to European practice in the number of boilers so fitted.

In designing a boiler for use without an economizer, additional efficiency may be secured by adding to its height. Increasing it from, say, 14 to 20 tubes high will result in a considerable increase in efficency without a corresponding increase in the draft loss, as much of the draft loss in boilers comes through the turns made by the gases in passing over the baffles.

Wrought-steel economizers are coming into use to a greater extent than formerly. We have found that, if the oxygen content of the feed water is reduced so that it does not exceed 1-5 c.c. per liter, the corrosion is reduced to a point where it will not give trouble.

To avoid exterior corrosion through the condensation of moisture from the flue gases, the temperature of the feed water to the economizers must be kept above a temperature of about 120 dg. F., and for most work we recommend 140 deg. F., as this allows for some leeway in case the water is fed intermittently. There is more difficulty through exterior corrosion in intermittent service than where the service is more or less continuous, as soot that collects on the outside of the economizer is likely to become moist where the economizers are down or are being started up, and the presence of moisture makes the soot from certain fuels highly corrosive.

It is becoming more general practice to use an individual economizer on each boiler and not to install connections for bypassing the bases around the economizer. A bypass connection as a rule allows some leakage of the hot gases and causes a continual loss of efficiency, and its omission is also advantageous in simplifying operation and lessening the chance of trouble with the economizers.

Brickwork in Furnace Design

For securing the highest efficiency the furnace temperature should be the maximum that can be maintained, and combustion should be completed within the furnace chamber. The furnace brickwork employed to-day will fail if saturated with heat at the full temperature that is available with many classes of fuel. In furnace design, therefore, some efficiency must be sacrificed in most cases in order to maintain the furnace brickwork and keep the cost of repairs within a reasonable figure. If it were possible to secure refractories for furnace construction that could be brought up to the full available temperature, the art of furnace design would be considerably changed, but as it stands to-day most of the thickness of the brick work must be cooled to a temperature below, say, 2,200 deg. F. in order that the bricks or tiles will carry the load imposed on them. To accomplish this a sufficient amount of the heat absorbed by the brickwork must be dissipated either through radiation or convection.

Where furnaces are operated under a suction that causes the cool air to be drawn inward through the brickwork, there is a cooling effect that serves to prevent overheating, whereas if they are operated under a pressure, there is a tendency for the hot gases to leak outward and overheat the brickwork. The difference between running with a slight suction of, say, 0.10-in. water column and a plus pressure within the furnace may make all the difference between successful operation and having a lot of trouble. If it were possible to operate with a plus pressure and maintain the brickwork irrespective of the temperature to which it would be raised, more economical results could be secured in most cases through the elevation of the furnace temperature. The exception would be where the elevation of temperature would interfere with the combustion; for example, with some kinds of coal too high a temperature might fuse the ash and clinker and cause the coal to mat down on the grate so as to greatly increase the air resistance through the fuel bed and reduce the available capacity. Again, if it were possible to bring the brickwork up to the full furnace temperature, arches could be used for certain purposes in furnace design where they can not at present.

Brickwork will fall by plastic deformation before it reaches the melting point.

*Abstract of a paper delivered before the Cleveland Engineering Society and local section American Society of Mechanical Engineers at Cleveland, and the Akron Section at Akron, Ohio, April 26 and 27, 1921.

The greater the load carried by the brick the more likely it is to fail. Fireclay brick of the best quality ordinarily obtainable begins to show plastic deformation under a load of 20 lb. per sq. in. at from 2,200 to 2,400 deg. F. Reduction to a load of 10 lb. per sq. in. will increase the permissible temperatures about 200 deg. F. As furnace temperatures considerably higher than this exist with certain grades of fuel and stoker practice, say, 2,700 to 3,000 deg. F. as a limit, it is apparent that the necessity of maintaining the brickwork below the temperature of the furnace is a vital one. First-class clay brick have a fusion point slightly above 3,100 deg. F., and yield through plastic deformation long before they fuse.

In ordinary furnace design the walls and arches are heated on one side only in order that the brickwork may be maintained at a lower temperature than that of the furnace. Arches will give trouble if heated on both sides which would not if subjected to the same amount of heat on one side only. This sometimes makes necessary the use of double arches, one directly above the other, with a small amount of air admitted between them for ventilating and cooling. A wall of a given thickness that would give good service as a battery wall might fail under the same fuel and combustion conditions if used as a supporting wall between two combustion arches, as the heat would not be conducted away from the wall to the extent that it would when used as a battery wall, and the reflected heat from the arches would also increase its temperature. Such a supporting wall should be used between combustion arches only in cases where a low grade of fuel is burned which does not result in high temperatures, or it should be ventilated.

To consume the combustible gases within the furnace chamber there should be a proper length of flame travel before the gases strike the tubes and a sufficient furnace volume. Furnace volume and length of flame travel are not, however, the only elements that must be considered in designing an efficient furnace, as there must be a mingling action within the furnace to cause any unconsumed combustible gases to reach the excess air.

Effect of Radiant Heat

The effect of the absorption of radiant heat on the boiler tubes should be considered in designing a furnace. With certain fuels such as blast-furnace gas, wet wood or bagasse, where the highest attainable temperature can be carried by the brickwork, it is best to absorb but little radiant heat in order to maintain a high furnace temperature and thereby increase the efficiency of combustion. With the stronger fuels it is necessary to absorb a considerable amount of the radiant heat in order to prevent the collapse of the brickwork or an undue amount of deterioration.

Few realize how great a proportion of the heat may be absorbed by a boiler as radiant heat. In underfeed-stoker practice, with the baffle arrangement ordinarily offered with Babcock & Wilcox boilers, the absorption of radiant heat with the boiler operated at its normal rated capacity is over 60 per cent. of the total heat absorption. Exposing more or less of the boiler surface to the direct radiant heat of the fire has a comparatively small influence on the efficiency, as any increase in the heat absorbed through direct radiation is counterbalanced to an extent by the diminution of the amount of heat absorbed through conduction. Ordinarily, the higher the furnace temperature the higher the efficiency. Higher furnace temperatures, however, lead to increased cost of brickwork maintenance, especially when the boilers are operated at high ratings, and for a strong fuel it usually pays to expose a considerable proportion of the heating surface of the boiler to the direct action of the radiant heat.

Percentage of Rating for Economical Operation

A question often arises as to what is the most economical capacity or rating at which a boiler should be run. This cannot be answered in a general way, as it depends on the load conditions as well as on the class and cost of the fuel. The economical rating is naturally influenced by the presence or absence of economizers and the service to which the boilers are put. Where there are short peak-load periods, the greatest commercial economy is usually secured by operating the boilers to as high a capacity as can be secured during these periods. Each case must be considered by itself and the fuel economy worked out for the actual conditions of service. The effect of the additonal cost of upkeep must naturally be considered.

The general practice in this country is to drive boilers at a higher rating than is done in European practice, and the stress of war conditions has undoubtedly led to a number of plants being run beyond the point of the best commercial efficiency. The fact remains, however, that boilers are being run at higher and higher capacities in our modern power plants, and the tendency seems to be upward rather than downward.

A furnace for operating at high capacities should be larger than for operating at lower capacities; a furnace to give economical results at high rating therefore involves special problems in caring for the expansion of the brickwork and especial care in the construction of buckstays for holding the brickwork in alignment. The general tendency in large furnace walls which are highly heated, is to bulge inward toward the fire, and unless some means are provided to prevent this, they may collapse.

In our present practice we use bonding tile which are held by cast iron bulb pieces attached to the buckstays in such a way that the wall can expand in any direction in a generally vertical plane, whereas it is prevented from either bulging inward or outward. Another means that may be employed to prevent the walls bulging inward toward the fire is to build them with a camber having a vertical axis, that is, curved slightly, with the concave side next the furnace.

Difficulties Encountered From Slag

In operating at higher ratings, difficulties are encountered with some grades of fuel through slag adhering to the boiler tubes and restricting or closing up the passage-ways for the flow of the gases. The difficulty through slag can be reduced by providing a relatively large area for the flow of the gases on entering the spaces between the tubes and by furnishing access doors through which the slag can be detached from the tube. An air lance, which is used both for cooling the slag and as a rod for striking it to remove any portion that may adhere to the tubes, forms an efficient tool for use in connection with the access doors.

The difficulty through slag is essentially a stoker-operating difficulty. Carrying a thick fire may result in but little slagging action, whereas this may cause trouble with the stoker itself through clinker. Thinner fires may remedy the clinker difficulties but result in a greater amount of slag being deposited on the boiler tubes. With certain grades of coal there will be some accumulation of slag on the boiler tubes with the stokers most carefully operated, and it is advantageous in such cases to provide access doors for removing the slag. Steam-jet blowers serve to reduce the amount of slag which will collect on the tubes, but are not a complete remedy so that it is often well to provide access doors.

How to Reduce Clinker Trouble

Trouble from clinker at the sides and front walls of the furnace where underfeed stokers are used is often reduced by admitting air through a number of openings in the walls at the sides of the fuel bed. The air flows in a layer against the inner face of the wall and prevents the clinker adhering to them. It also serves to partly cool the wall and reduce its erosion.

A stoker-operating difficulty that arises in some cases is the formation of a clinker which will cause the air admitted under a blast pressure to produce a jet or torch-like action that will result in fusing the brick so as to melt out or erode away a part of the wall. The stoker tuyeres may also cause jets of air to be projected against the wall so as to erode away certain parts of it.

It can readily be seen that furnace design and boiler design must be coordinated in order to secure the best results. It is impossible to separate boiler efficiency from the efficiency of the stoker and furnace. Many have worked

The Calculation of Boiler Performance

Horse Power Rating of Boilers—The Standard Definition—The Calculation by Reference to the Equivalent Evaporation—Chart For Quick Determination of the Factor of Evaporation

By W. B. CAMPBELL

By W. B. CAMPBELL

THE object of a boiler is of course to make steam, and on the face of it the most natural gauge of how much work it has done is the amount of steam it has produced, or, what is the same thing, the weight of the water it has turned into steam. But this is only the roughest kind of an approximation as to the working capacity of the boiler, because the pressure at which steam is produced makes a big difference. High-pressure steam is worth more in the engine than low-pressure steam, and is harder to make, and the additional service should properly be credited to the boiler. In fact, the only fair basis on which to state boiler performance is heat transferred to water. Heat is potential work, and the work to be had from steam is a function of the amount of heat in it, so that the heat content indicates the value of steam for power purposes. The production of steam is a problem of forcing heat through boiler tubes at a desired rate, so that steam-making can be judged by the heat transferred, whether to a small quantity of steam at high pressure, or a larger quantity at low pressure.

While the heat transfer could logically be expressed in B.t.u. an hour, the practical unit is the boiler h.p. B.t.u. are used only for figuring. No one has even seen one; and while a boiler h.p. is equally imaginary, it is a convenient idea, and has been used so long that 50 or 100 or 1,000 boiler h.p. suggests to the engineer a certain relative size of equipment, and indicates the ability to give a certain amount of service.

All horse-power ratings are purely arbitrary. A horse-power as a rate of doing work represents more than any ordinary horse could possibly do, for the reason that when Watt first started to sell his engines on horse-power basis, he purposely under-estimated their possibilities, which were greater than he could make people think they were. They were "too good to be true." When the engine h.p. was later defined on a scientific basis, it was therefore given the rather high value of 550 foot-pounds a second, or 1,980,000 foot-pounds an hour.

In a similar way the boiler h.p., now defined on an arbitrary basis, was intended to represent the production of steam at a rate which would serve to produce an engine h.p. At the time of the Centennial Exposition in Philadelphia, in 1876, the Committee of Judges established as a unit that a boiler h.p. should be the evaporation of 30 pounds of water an hour, receiving it as feed-water at 100 degrees and delivering it as steam at 70 pounds gauge pressure. Steam at 70 pounds contains 1,108.1 more B.t.u. a pound than does water at 100 degrees, so that the making of 30 pounds of steam an hour under such conditions represents the transfer of $30 \times 1{,}108.1 = 33{,}243$ B.t.u. an hour.

Subsequent to this the method was adopted of figuring on an "equivalent-evaporation" basis. The greater part of the work of producing steam is in supplying the "latent heat of vaporization," the heat which turns water into steam, changes its state without affecting its temperature, and is therefore considered as latent or hidden. The heat required to raise water from the feed temperature to boiler temperature varies, the latent heat required to evaporate it varies with the boiler temperature and pressure, and if super-heated additional heat is transferred. All of these heats can be added and reduced to the equivalent amount of water which they would evaporate from and at 212 degrees. It requires exactly 970.4 B.t.u. to change one pound of water at 212 degrees to steam at 212 degrees, and we therefore reduce by dividing the heat transferred by 970.4. The modern definition of a boiler h.p. by the American Society of Mechanical Engineers is the heat-transfer rate equivalent to the evaporation of 34.5 pounds of water an hour from and at 212 degrees. $34.5 \times 970.4 = 33{,}479$ B.t.u. an hour. This is only one-half of 1 per cent. more than the B.t.u. in the old Centennial definition, and the 34.5 pounds definition gives an easily calculated and well-recognized unit. It is universally used, and boiler performances are calculated on this basis. The actual weight of water evaporated is converted to the "equivalent evaporation" by the use of a factor of evaporation. A factor of evaporation of 1.15 means that for every pound of water actually evaporated, 1.15 pounds must be considered as having been evaporated—that is, the actual evaporation must be multiplied by 1.15. This equivalent evaporation is the only basis on which different boilers can be compared, or by which tests of the same boiler at different times, with different fuels, different baffling, different firing rules, different feed-water temperatures and gauge pressures, different rates of driving, etc., can be compared. The formulae for factor of evaporation are given below, although the results are all embodied in the chart:

$$F = \frac{(h + L + s\,S) - f}{970.4};$$

where

F = factor of evaporation;
h = heat of the liquid in saturated steam at boiler pressure, expressed in B.t.u. above 32 degrees a pound, taken from steam table;
L = latent heat of vaporization at boiler pressure, B.t.u. a pound;
S = degrees of superheat, or the excess of the steam temperature over what it would be for saturated steam at same pressure;
s = average specific heat of superheated steam (about 0.5 B.t.u. a pound a degree of superheat);
f = heat of the feed-water, B.t.u. above 32 degrees a pound. This can be taken from steam table, but is approximately equal to the feed temperature, minus 32;
970.4 = B.t.u. required to evaporate one pound from and at 212 degrees F.

The more exact value of s is

$$0.43 + 1{,}476{,}000 \frac{\text{gauge pressure}}{(\text{temp.} + 460)}.$$

Using this formula for saturated steam at 75 pounds gauge evaporated from water at 180 degrees—

$$F = \frac{290 + 894 + 0 - (180 - 32)}{970} = 1.06.$$

Turning to the chart, we start at the 75-pound gauge pressure point at the bottom of the right-hand half, run up vertically to the horizontal "dry saturated" line; the intersection lies between the fourth and fifth curved lines. Follow at the proper distance between these lines to the "north-west" till we strike the 180-degree feed-line, and we find the factor of evaporation to be 1.06.

If we have steam at 170-pound gauge and 75 degrees superheat from feed-water at 190 degrees, we follow the 170-pound line up to the 75-degree superheat line (as shown dotted on the chart), then follow the curves in the direction shown dotted to the 190-degree feed line, and find the factor of evaporation to be 1.095.

The line below the gauge pressures gives the temperatures for saturated steam at each pressure. These relations are established; steam in contact with water is necessarily at a temperature corresponding to its pressure. However, in a superheater, steam will be at the same pressure as the rest of the boiler, but takes up additional heat which heated steam faster than it has a chance raises the temperature of the super-

to equalize itself. The excess temperature over that belonging to the pressure is the amount of "superheat"; if not stated directly, it is obtained by subtracting the saturation temperature from the final or actual temperature.

The quality of steam is expressed as a percentage of the whole weight which is really steam, and not small drops of water carried over. If the quality is over 96 per cent. it can be estimated by expanding the steam to atmospheric pressure through a throttling calorimeter, and noting the resulting temperature.

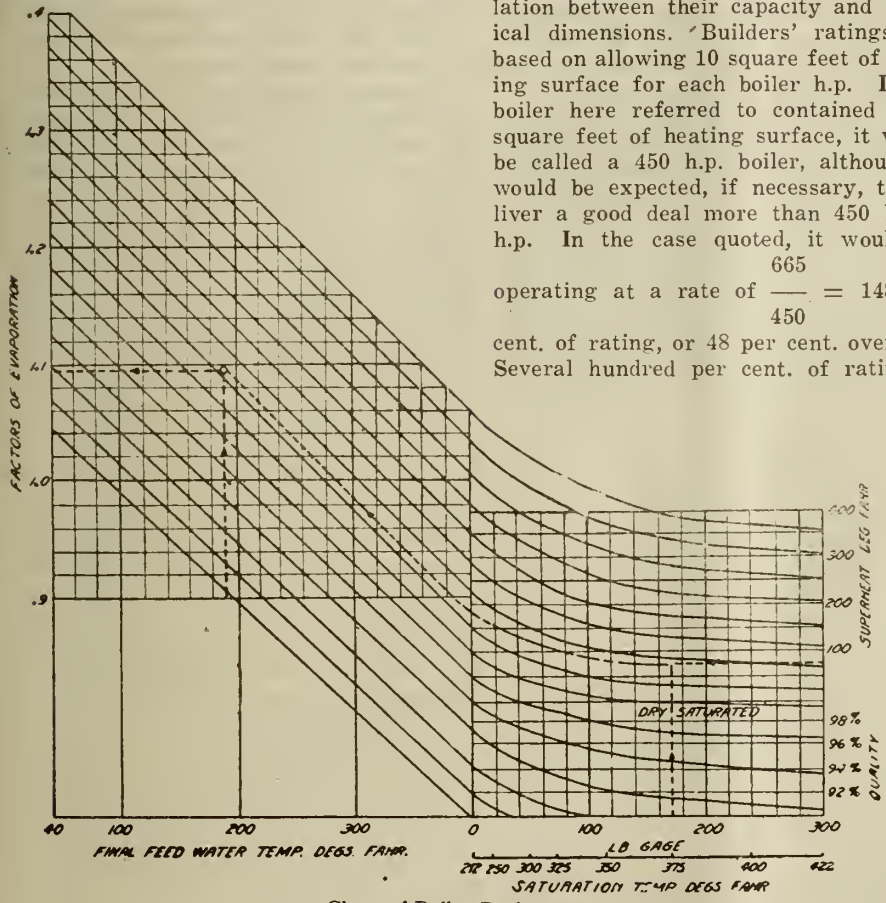


Chart of Boiler Performance.

$$Q = \frac{1{,}150.5 - h + 0.46\,(t - 212)}{L};$$

where

Q = quality of steam;
h = heat of liquid at boiler pressure, from steam table;
t = temperature after expansion;
L = latent heat of steam at boiler pressure, from steam table.

If the steam is "wet" in this sense, the equivalent evaporation must be corrected accordingly, as each drop of water carried over while it is at boiler temperature has not taken up any heat of vaporization. This is allowed for in the lower part of the right-hand chart. For the evaporation of 200-degree feed-water to steam at 200-pound gauge pressure, 98 per cent. quality, follow the 200-pound line to the horizontal 98 per cent., then the curve to the left to the 200-degree line, and factor of evaporation equals 1.04.

As stated above, the equivalent evaporation is the actual multiplied by the factor. For instance, if 500,000 pounds of water is actually fed to and evaporated by a boiler in 24 hours and the factor of evaporation is 1.1, the equivalent evaporation is 550,000 pounds in 24 hours.

$$\text{Boiler h.p.} = \frac{550{,}000}{34.5 \times 24} = .665 \text{ h.p.},$$

and this is the average boiler h.p. actually developed during the day. Boilers are driven at so many different rates that it is hard to establish an exact relation between their capacity and physical dimensions. Builders' ratings are based on allowing 10 square feet of heating surface for each boiler h.p. If the boiler here referred to contained 4,500 square feet of heating surface, it would be called a 450 h.p. boiler, although it would be expected, if necessary, to deliver a good deal more than 450 boiler h.p. In the case quoted, it would be operating at a rate of $\frac{665}{450} = 148$ per cent. of rating, or 48 per cent. overload. Several hundred per cent. of rating is delivered by large units during peak-load periods, although with some loss in efficiency.

This equivalent evaporation can also be used as a gauge of the performance of the boiler and furnace with respect to the fuel used. For the figures quoted, if the evaporation was secured by burning 70,000 pounds of coal containing 2 per cent. moisture and 8 per cent. ash, the equivalent evaporation a pound of coal would be $\frac{550{,}000}{70{,}000} = 7.85$, the equivalent evaporation a pound of dry coal would be $\frac{550{,}000}{70{,}000 \times 0.98} = 8.01$, and that for a pound of combustible would be $\frac{550{,}000}{70{,}000 \times 90} = 8.71$. If the refuse from the furnace was 11 per cent., the equivalent evaporation per pound of combustible actually burned would be

$$\frac{550{,}000}{70{,}000 \times 0.87} = 9.02.$$

Efficiency (combined) of boiler, furnace and grate is figured by comparing the heat transferred to steam with the potential heat in the fuel. The latter is generally determined in a calorimeter by burning a small sample of the fuel in a closed bomb, under such conditions that the full heat is developed, and is measured by allowing it to heat a known quantity of water surrounding the bomb, a B.t.u. being defined as the amount of heat required to heat a pound of water 1 degree F. The heat value of coal runs from 13,000 to 16,000 B.t.u. a pound.

Each pound of equivalent evaporation represents 970.4 B.t.u. transferred, therefore the efficiency equals

$$\frac{\text{Equiv. evap.} \times 970.4}{\text{Weight of coal} \times \text{heat value}}.$$

In the example, if the coal contained 13,800 B.t.u. a pound of dry coal, the efficiency would be

$$\frac{550{,}000 \times 970.4}{70{,}000 \times 0.98 \times 13{,}800} = 56.4\%.$$

This means that 56 per cent. of the potential heat in the coal has been successfully transferred to steam. A heat balance can be made to cover the various source of loss, such as the evaporation of moisture in the coal; heat carried off in steam made when the hydrogen in the coal burns; heat lost in flue gases, depending on their temperature and the amount of excess air in them, indicated by the CO_2 analysis; any unconsumed CO in the gas, unburned coal in the refuse, moisture in the air, radiation, etc.—"Southern Engineer."

POINTS IN BOILER DESIGN

(Continued from page 27.)

on this problem, and the ground has probably been gone over more thoroughly than any other feature of boiler-testing codes. The result has always been in reaching the conclusion that it is impossible to separate the furnace and stoking efficiency from the combined efficiency of the boiler, stoker and furnace in such a way that the result may not be misleading.

HINTS OF VALUE

Shortly after a fire in a certain plant in England the following hints were given: Don't store oily cotton waste in a warm place at all, and don't store it where firing will cause danger anywhere. Under favorable conditions oily waste, as well as some other things, will oxidize rapidly, and in the presence of air will ignite through the heat engendered; and this should be thoroughly knocked into the heads of people handling the stuff in workshops, as it is quite easy to have a fire from some "unknown cause," or of which the "origin unknown" report is given by the fire brigade.

A Course of Instruction for the Graded Certificate

In This Article Some Illustrations Are Given of Cards From a Slide Valve Engine and Their General Appearance Explained. —These Are the Most Simple Examples of Indicator Cards

By T. H. FENNER

THERE is probably no more interesting operation to the average engineer than taking indicator cards to observe the internal working of his engine. A proper understanding of the diagram drawn by the indicator is a big help to the efficient working of the plant. We have to consider first of all the indicator card in its relation to valve setting. Let us take first of all a slide valve engine, and assume that the valve and eccentric have been set approximately, and we are now about to make final adjustments by means of the card.

After adjusting the cord so that we are sure the drum of the indicator will not come up against its stops at either end of the stroke, and allowing the steam to act on the piston from each end of the cylinder for a few strokes to get the indicator pipes clear of moisture and to make sure the indicator is working freely, a card is placed upon the drum and we are ready to go ahead. A card is taken from each end of the cylinder on the same paper, so that we can have an indication of the relation of the two ends to each other. The cards obtained from the engine will depend a great deal on whether the governing is by throttle or by automatic cut-off. We will first consider the throttling governor, and the engine running light. Assuming that the initial pressure is 100 pounds and we are using an 80-pound spring, we will not expect to get a card much more than an inch high at its highest point. The throttling governor will cause a considerable wire drawing of the steam, so that the pressure in the steam chest will be low, and the steam line will drop rapidly, the point of cut off of course remaining the same whatever the load condition may be. The card we will get would be somewhat similar to Fig. 1.

The steam line is lower than the height corresponding to the initial pressure due to the wire drawing as already explained. From the beginning of the stroke the steam line will drop rapidly in a practically straight line until the cut-off point is reached, and the pressure will very likely drop below its atmospheric line before the exhaust opens. There will be but little compression, owing to the steam remaining in the cylinder being at atmospheric pressure.

These cards will be useful only in a general way to show how the distribution is divided on each side of the piston. If there is any serious discrepancy between the points of cut-off and compression on head or crank end it will be shown, but if the cards appear fairly even we must get some load on the engine to give a clearer indication. With the steam very much throttled it becomes a difficult matter to determine just where the cut-off point is, and also the compression but with the engine working at about its full load we can see clearly what is taking place.

The card shown in Fig. 2 is a good example of a slide valve engine cutting off about half stroke, and with the valve set at practically the best position. It will be noticed that the cut-off takes place at about the same point in the stroke at both ends of the cylinder, compression takes place similarly, and cut-off is even. The work done at each end of the cylinder will be practically the same, allowing for the slight loss in

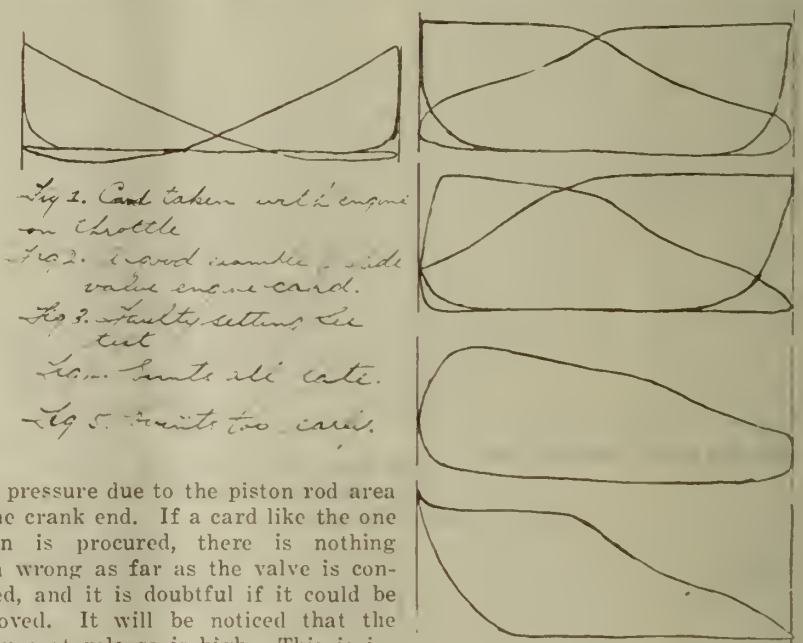


Fig 1. Card taken with engine on throttle
Fig 2. Good example of slide valve engine card.
Fig 3. Faulty setting of cut
Fig 4. Suits all cases.
Fig 5. Suits two cases.

total pressure due to the piston rod area on the crank end. If a card like the one shown is procured, there is nothing much wrong as far as the valve is concerned, and it is doubtful if it could be improved. It will be noticed that the pressure at release is high. This is inevitable in plain slide valve engine working with an unvariable cut-off. The practically straight steam line shows that the ports are ample in size to supply the steam up to the point of cut-off, and the straight exhaust line shows that the steam is released speedily and without any accumulation of back pressure.

The next figure shows a card indicating faulty valve setting, and we must look into this carefully before deciding what is the matter and what is the remedy. Taking the left hand card first, we note that the admission line slopes inward from the end of the card, and that the piston has started on its stroke some little time before the steam has attained its maximum pressure. Following the steam line along, we note that the pressure does not keep up as in the former figure and that the cut-off takes place earlier than in the first card. The expansion curve is shorter owing to the fact that the valve opens to release earlier, while on the return stroke, the valve does not close to exhaust till nearly the end of the stroke, making the compression curve small.

Let us now consider the card from the other end of the cylinder. Here the conditions shown are practically the opposite. The valve opens to admission earlier, thus giving a line sloping outwards to the end of the card, and resulting in the pressure being reached before the piston is at the end of its stroke. Following along we find that the cut-off takes place later, and the expansion curve is continued further before release takes place. Tracing along the exhaust line we find that the compression curve starts sooner, and is larger than on the opposite side. What do we deduce from all these points? We find that on the left-hand card we have some events early and others late, while on the right-hand card we have the events occurring in an exactly opposite manner. That is, where admission is early in one case, it is late in the other; where cut-off is early on one end it is late at the other. What is the fault and what is the remedy with this valve setting? Taking the left-hand card first, and neglecting for the moment whether that is the head or crank end card, we see that admission is late and cut-off early, while release is early and compression late. From this card we judge that the valve should be moved

on the spindle. Let us assume that the left-hand card is taken from the crank end, then the valve should be moved on the spindle away from the crank. However, we must consider what effect this will have on the card from the other end. In this card we have admission early, cut-off late, release late and compression early. The valve being moved on the spindle towards the head end will also correct these faults. It might be that merely moving the valve on the spindle would not be enough, and in that case the eccentric would have to be moved ahead a small amount and the valve adjusted on the spindle to make each end correct.

Let us consider a moment the case if, still considering the same pair of diagrams, the left-hand card had been from the head end and the right-hand had been the crank end card. In that case in order to correct the head end we should have had to move the valve towards the crank end. This, however, would have tended to neutralize the early lead and late cut-off on the crank end which is what we want to keep. The remedy then would be to advance the eccentric, to make the head end correct, and to move the valve back on its spindle to make the crank end correct.

Where every event is early as we have seen in previous articles the remedy is to turn the eccentric back. Where everything is late the remedy is to turn the eccentric ahead. If the reader will turn back at this stage to the Zeuner valve diagrams that were discussed in the earlier lessons, he will be able to derive considerable help therefrom. In studying a card remember always this rule. If two events are late and two early the valve must be moved on the spindle to correct those faults. If correcting the fault this way is going to make the other end of the cylinder wrong, then the remedy is to move the eccentric a little way to make everything early or late, and then make the adjustment on the valve spindle. If all events are either early or late move the eccentric. This is a general rule which covers all cases, but there are many modifications which become necessary according to conditions. With a simple slide valve engine there are only the two operations possible but with four-valve engines there are, of course, a number of other adjustments to be made.

The cards shown here are fairly typical cards from a slide valve engine without any complications, and should be quite simple for the student to follow. As we go into this subject we shall have much more complicated illustrations, but we just start at the beginning. It is so easy to draw wrong impressions from the reading of a card that we want to make it very clear in these articles just what each sign means.

When studying a card always approach it from the angle of the perfect card and note where the events differ from that. You won't have a perfect card always with you, but you should retain a very good idea of what it looks like in your mind. Another useful thing is to apply the diagram shown earlier and which we reproduce again here showing the direction of the valve and direction of the piston throughout the stroke. This applies not only to slide valve engines, but to any other kind of engines, and is a most useful thing. Get familiar with the main facts of the card's message, and then you will soon be able to recognize faults and their remedies as soon almost as you look at the card.

AN UNUSUAL FATALITY

In the course of an inquiry into certain types of water tube boilers used in the British navy during the war, and defects that occurred therein, a most unusual fatality was mentioned.

During the hydraulic testing of one of these boilers, a failure of the sheet occurred, in such a way that it split open about three feet along the length, and a sheet of water was projected through the crack. This water was, of course, at very high pressure, probably in the neighborhood of 700 or 800 pounds per square inch, and possibly more. One of the men engaged in the test was stationed at the place where the fracture occurred, to watch the necks of the tubes for leaks, and the sheet of water issuing with such force cut him in two. This is one of the strangest accidents we have ever heard of in a long experience. It shows that there can be danger where it is least expected. As everyone knows the reason that water is used for testing vessels under pressure is because there is no danger of explosion if anything gives way. Water being incompressible, that is practically so, a sudden rupture would merely result in a drop of pressure. However, in a case such as is mentioned above, the opening made in the plate was of very small area, and the man being close up to it received the full force of the jet issuing from it, and probably the pump was still working when the accident occurred.

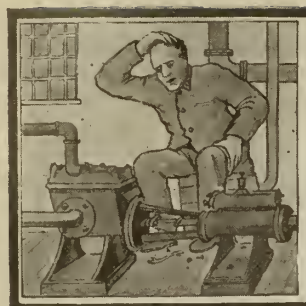
We remember an incident that showed very vividly the power of a jet of water at high pressure. The occasion was that of testing some hydraulic valve boxes to a pressure of 2,000 pounds per square inch. The nipple to which the pressure gauge was connected failed in some way, and the gauge parted company with it. A jet of water issuing from the opening carried the gauge up and up till it reached the roof of the building, and a skylight being directly in its path went through this and out into the street beyond. That roof was a good sixty feet, the building being the erecting shop of a large engineering firm. That was in no sense an explosion, but merely a jet of water at high pressure which gave the gauge the initial velocity which carried it on its upward path. Thinking of this makes it more easy to understand the knife-like force that the sheet of water issuing from the boiler would have to enable it to cut a man in two.

The U. S. Bureau of Standards has made an interesting investigation on the influence of abrasion on the hardness of the various types of steels. "In all cases, except the high-carbon austenitic steel," says the report, "no pronounced effect of abrasion upon the steels used in these experiments was observed. In all cases the hardness of plain carbon steel containing 0.85 per cent. shows the greatest increase in hardness. The alloy steels generally show a smaller increase in hardness of abraded surface than plain carbon steels, and in some cases they show a decrease of surface hardness. High-carbon austenitic steel shows a marked decrease of Brinell and scleroscopic hardness. This process of abrasion viewed in the light of Beilby's theory may be considered as resulting in the reduction of amorphous matter at the expense of crystalline matter, which affects the hardness of the abraded surface of the metal, but probably not the general character of its structure.

Newcastle, in Northern Natal, situated on the main line about half way between Durban and Johannesburg, and long noted for its coal fields, is likely soon to be also an important ironworks center, states the London Ironmonger. The Newcastle Iron and Steel Works, of which J. K. Eaton is the managing director, are nearly completed, and it is expected that the production of pig iron will commence in the early summer. Owing to the scarcity of cast iron at a reasonable figure. It is said that the Newcastle company will be able to sell its products at about the present price of cast iron scrap, which is what the South African foundries greatly need.

RAIL JOINT WELDING

The welding of rail joints where the rails are laid in paved streets, or when the main highways cross the tracks, is becoming popular with the steam railroads in the United States. The Baltimore & Ohio is said to have been the first railroad to adopt the welding of rail joints, nearly one hundred joints being welded on Pratt street, Baltimore, in 1917, the rails in this instance weighing 141 lbs. to the yard. The success attending the innovation has led to its extensive use. In the case of highway crossings the general practice is to weld three rails together in the nearest shop and quickly install them without interfering with the traffic. Once installed, they may be said to require no further attention, as no joint repairs are necessary, many having been in service for a lengthened period without showing signs of weakness or failure.



OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

SURFACE OR JET CONDENSER

Question:—What is the advantage of a surface over a jet condenser, or is there any particular advantage? Which one will give the highest vacuum? What would determine the choice?

Answer:—Surface and jet condensers are used in different places according to the conditions as to feed water, circulating water, etc. With a jet condenser the exhaust steam mixes with the condensing water, and if this water is not fit for boiler feed, both exhaust steam and condensing water are lost. The jet condenser is a very simple affair, the circulating pump and condenser being self-contained. If it is intended to use the exhaust steam to feed the boiler it is better to use a surface condenser. In this case besides the circulating pump an air pump must be used, to draw the condensation from the condenser and deliver it to the hotwell, where the feed pumps return it to the boiler. As a rule in stationary practice, where feed water is cheap, no attempt is made to return the engine exhaust to the boiler. In some cases, the circulating water and exhaust steam from the jet condenser are returned to the hotwell. This is the exception, however, and usually in stationary practice the amount of oil in the exhaust precludes the use of the condensation in the boiler. The surface condenser is mostly restricted to marine work, where the exhaust must be used for feed water, and where the consumption of cylinder oil is cut down to a minimum. In large central stations using turbines surface condensers are sometimes fitted. Generally speaking the surface condenser with air pump will give a better vacuum than the simple jet condenser, but a barometric jet condenser with dry air pump will give very high vacuum if everything is kept tight.

HOW LONG SHOULD BOILER BE RUN?

Question:—What is the longest time that it is safe to run a boiler without washing out, and can a horizontal boiler be run longer than a water tube?

Answer:—The length of time between washing out a boiler will depend on the quality of the feed water, and the rate the boiler is worked. If the boiler is run at normal rating, it will require cleaning less often with the same quality of feed water as if it was run at 150 or 200 per cent. over rating. With a horizontal return tube boiler and ordinary good water, the boiler should be opened up once a month under ordinary circumstances. That is long enough to run this type of boiler, and of course if conditions are hard more frequent opening up will be required. With a water tube boiler it is different, and they can be run anywhere from two to six months with perfect safety. In the horizontal type of water tube boiler the lower rows of tubes can be examined from time to time and their condition is a good guide to the rest, for the lower rows get the most heat, and therefore will have the heaviest deposit. In general, would say that the length of time a boiler can be run depends entirely on local conditions but the above limits are reasonable.

SAFETY VALVE ADJUSTING RING

Question.—What is the adjusting ring on a safety valve, and how does it act?

Answer.—When a safety valve lifts it is under greater compression than that due to the initial compression of the spring, due to the extra compression it gives by lifting from its seat. To overcome this a lip is formed on the valve, so that when it opens the arc of the valve is greater than when it is closed. This extra area gives a greater force to the lifting effect of the steam. The adjusting ring is made to screw up or down to approach closer to this lip or further away from it. When it is close to the lip the steam has not such a free discharge, and it will take a greater drop in pressure before the spring can overcome the upward force on the valve. When the ring is far away from the valve the steam has a freer discharge and does not act so directly on the lip of the valve, therefore the valve will close with a much less drop in pressure, giving the pop action from which the valve gets its name. The ring can be adjusted while the valve is discharging by means of a rack, which can be reached through a small hole in the body of the valve.

DYNAMO OR MOTOR

Question.—What is the difference between a dynamo and a motor?

Answer.—The difference between a motor or dynamo is this: A dynamo is a machine for converting mechanical energy into electrical energy, while a motor is a machine for converting electrical energy into mechanical. Therefore if an electrical machine is driven by a prime mover it will deliver current on to a circuit, that is, it will be a generator. If you take the same machine and connect it up to a source of electrical power and supply it with current it will in turn drive any other machine by means of a belt or being directly coupled.

FINDING THE SIZE OF PUMP

Question.—How would I find the size of pump required for a boiler evaporating so many pounds of water per hour?

Answer.—The way to find the size of pump required is as follows: Supposing that each pound of coal evaporates 8 pounds of water, and the coal consumption is 500 pounds per hour then you will have to feed 4,000 lbs. of water per hour. This is equivalent to 4,000 divided by 62.5 or 64 cubic feet of water per hour. Allowing that you wish the pump to run about 24 strokes per minute, or 12 double strokes, which is the same thing, the pump will move if 100 per cent. efficient 64 divided by 60x24 cubic feet per stroke. As you must allow for slip, and it is best to be on the safe side, the pump should be considered only 80 per cent. efficient, and should therefore be large enough to move $\frac{64 \times 120}{60 \times 24 \times 100}$ cubic feet per stroke. Multiply this to reduce it to cubic inches by 1728, the result being 92.16 cubic inches, or say 93 cubic inches per stroke. In order to have a long stroke we will assume twelve inches as the stroke, and the diameter will then be found by dividing 93 by $12 \times .7854$ and extract the square root or $\frac{93}{12 \times .7854}$ which gives a diameter of a little over three inches. This is not a very well proportioned pump, so we will try a shorter stroke and larger piston. Suppose we take the stroke at eight inches then we shall have $\frac{93}{8 \times 7854} = 3.84$ ins. dia. It would be well to make the pump 4 ins. dia. by 8 ins. stroke and then it could be run slowly. This proportion gives practically 100 cubic inches per stroke and with 24 strokes per minute you would have 2,400 cub. ins. per minute or 1.38 cubic feet. This multiplied by 60 gives 82.8 or say 83 cubic feet per hour. Allowing 20 per cent. for slip you have $\frac{83 \times 100}{120}$ 70 cubic feet per minute, which is more than we require, but gives a safe margin.

Programme of the C. A. S. E. Convention.

The convention to be held at Ottawa on the 28th, 29th and 30th of June promises to be the most successful in recent years. Everybody concerned has been putting forth strenuous efforts to secure a good programme, and a good collection of exhibits, and from all accounts have succeeded.

The exhibition will be held in St. Patrick's Hall, Laurier Avenue, Ottawa, and a very comprehensive round of entertainment for the delegates and visitors has been arranged by the entertainment committee.

The following official programme will give an idea of what awaits those attending:

Tuesday

10 a.m.—Meeting Grand Lodge C. A. S. E., R. C. Leach, president, in the chair.

11—Opening ceremonies, C. Berry, president Ottawa Lodge, in the chair. Speeches by civic representatives and visitors.

2 p.m.—Business session.

4 p.m.—Adjourn to Exhibition Hall to examine exhibits.

7.30—Boat trip, as guests of the Ottawa lodge.

Wednesday

9 a.m.—Business session.

1.30—Drive around city, leaving Convention Hall at 1.30.

2.30—Games at Exhibition Park.

8 p.m.—Entertainment at Convention Hall.

10—Drawing for prizes.

Wednesday Evening, E. F. Hetherington, Galt, chairman. Talent includes Jack Armour, E. B. Curzon, Bob Jones, Howard Fletcher, etc.

Thursday

9 a.m.—Business session.

Election of officers.

Selecting place of next annual convention.

10—Annual meeting Exhibitors Association.

2 p.m.—Open meeting C.A.S.E. for installation of officers.

Officers of Exhibitors Association

Honorary President: C. Berry, 40 Willows St., Ottawa.

Past President: J. S. Mock, 1305 Bank of Hamilton Bldg., Toronto.

President: C. B. Turner, 894 Bathurst St., Toronto.

1st Vice-President:Grant E. Cole, 1002 Dundas St. West, Toronto.

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The annual exhibition of power plant equipment and supplies will be held in St. Patrick's Hall, 77-79 Laurier Ave. West, Ottawa, June 28, 29 and 30, 1921.

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POWER HOUSE

JUNE 5th, 1921

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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TORONTO, CANADA
JOHN BAYNE MACLEAN, President
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The Thirty-Third Convention

AT the end of June the Canadian Association of Stationary Engineers will hold their thirty-third convention, the scene chosen for this year being Ottawa. Ottawa is a very pleasant city to hold a convention in, and there is no lack of interesting features from a power plant engineer's point of view. The close proximity of Hull will no doubt be far from a drawback, and furthermore there are some fine examples of industrial progress on that side of the Ottawa River. The immense plants of Booth's and Eddy's are well worth a visit, and these are not the only ones. On the Ottawa side perhaps the principal attraction from an engineering standpoint will be the new heating plant of the Parliament Buildings, while those who are interested in refrigeration will no doubt find a chance to visit some of the breweries which have their location in Ottawa. Apart from any question of engineering sight-seeing, Ottawa abounds in picturesque drives and trolley rides. The drive round the Rideau and out to the experimental farm will be found well worth while, and for those who want to go sailing or bathing Britannia Beach holds forth lots of attraction. The delegates ought to be able to put in three very good days.

The foregoing should be guarantee that there need be no dull times for the delegates in their off moments. There is another thing that we would respectfully draw to the attention of those attending the convention, and that is the exhibit supplied by the various manufacturers and agents of power house accessories and appliances. These firms go to considerable trouble and expense each year to make this exhibit, and they also do their share to make the convention a success from a social point of view. They are glad to do so, and want to see every convention a great success, each one better than the one before. In return all the exhibitors ask is that the delegates and visitors to the convention will spare a little time to visit the various exhibits, and ask for any information they may wish to acquire. It is well recognized that the delegates particularly are kept pretty busy, but at some period of the three days a spare hour can be found to look over the latest productions of the manufacturing engineers which will be found in the exhibition hall. The dates for the convention will be the 27th, 28th and 29th June and in the next issue of Power House we will publish the programme and all the information that will be of use to visitors.

A Remarkable Accident

THERE has been brought to public notice through the medium of an enquiry into the behaviour of water tube boilers of a special type during the war, a most unusual fatality.

Many ships of the navy were fitted with the Yarrow type of water tube boiler, and to those of our readers who are not familiar with this design, we may say that it consists of three drums, one on top and two below arranged in the form of a triangle. The lower drums are water drums, and the upper one a water and steam drum, and the upper and lower drums are connected together by small diameter tubes. In order to have these tubes straight the drums were flattened on the side where the tubes entered, and due to this construction, some failures occurred. One vessel's boiler blew up while she was in harbour, and there were several bad accidents on other war vessels accompanied by fatalities.

The case in question, however, is remarkable in that it occurred while the vessel was in harbour, and the boiler was being tested hydraulically. The pressure used is not given in the report, but as these boilers carry a working pressure very often of 300 lbs. per square inch it is safe to assume that the hydrostatic pressure would be at least 600 lbs. to the square inch. One of the men engaged in the test was stationed at the lower water drum, and was looking at the necks of the tube to see if there was any leak from them. In order to do this he would have to stand close up to the drum, and while so doing a failure occurred in the plate. The drum opened up along a length of about three feet, and a thin sheet of water was discharged through the crack. This sheet of water came out with such intense force that the man standing close up to the drum was cut in two, as though with a knife. Had the shell opened up wide the man would have been washed off his feet but the pressure would have been relieved so quickly that nothing very serious could have happened. In this case, the crack was probably not much more than one quarter to three-eights of an inch wide, and the man's body caught the force of the water right as it left the drum with the full pressure behind it.

We have never before heard of such a case, and trust that we never shall again.

LEADING ARTICLES IN THIS ISSUE

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In This Article the Subject of Pumps is Carried Further, and General Construction of the Water End and Method of Packing Explained.

Power Plant Instruments and Meters 24

The Operating Engineer of the Present Day Has Many More Instruments to Check His Work Than Had His Predecessor—These Instruments Are Classified and Their Use Explained in This Article.

Some Points in Boiler and Furnace Design . 26

Determining Whether an Economizer will Pay—Brickwork in Furnace Design—Percentage of Rating For Economical Operation—Difficulties Encountered From Slag—How to Reduce Clinker Trouble.

Calculations of Boiler Performance 28

Horsepower Rating of a Boiler—The Method of Calculating by the Factor of Evaporation—A Chart is Introduced by Means of Which the Factor of Evaporation Can Readily be Found.

Instruction for the Graded Certificate 30

In This Article Some Illustrations Are Given of Cards From a Slide Valve Engine and Their General Appearance Explained—These Are the Most Simple Examples of Indicator Cards.

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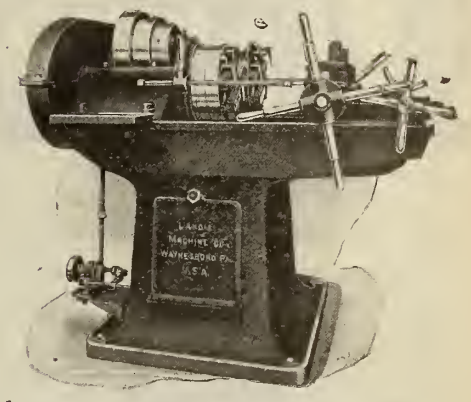
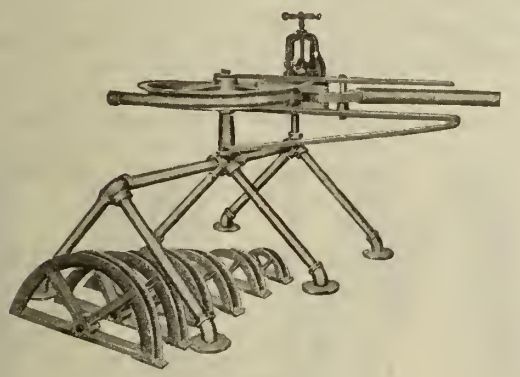
Our Question Box 34

Landis Bolt and Pipe Threaders have a world-wide reputation for reliability and accuracy



Landis Bolt and Pipe Threading Machines do better work more cheaply—and in less time—because of the distinctive design of the Landis Chaser, which operates in the same manner as a lathe tool. Placed at a tangent to the work, the bearing and friction on the cutting edge are at a minimum, allowing the machine to be operated at a higher speed than is possible when a hobbed type of die is used.

These features are contributive to economical production and explain, in part, why Landis Thread-Cutting Machines are considered standard equipment by leading manufacturers, whose hardest jobs they handle with complete satisfaction.



Pipe Benders

Here is a machine that bends all sizes of pipe, generally used, to any required degree easily, quickly, surely. It bends the pipe cold and does not weaken the metal or open seams. The "Wonder" Pipe Bender is so economical that the smallest shop may have one. Operated by unskilled workmen, it will bend a two-inch pipe to a 90-degree angle in less than a minute. Unlike an elbow joint, a perfectly bent pipe offers no obstruction to the flow of steam or water. Other Wonder Machines handle pipe and tubing from ⅛″ to 8″ in diameter.

We are the sole Canadian Agents and our nearest Sales Office will gladly send detailed information of special interest to purchasing agents.

If it isn't here —write us

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- Pipe Tools

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Canada's Departmental House for Mechanical Goods

Fairbanks-Morse

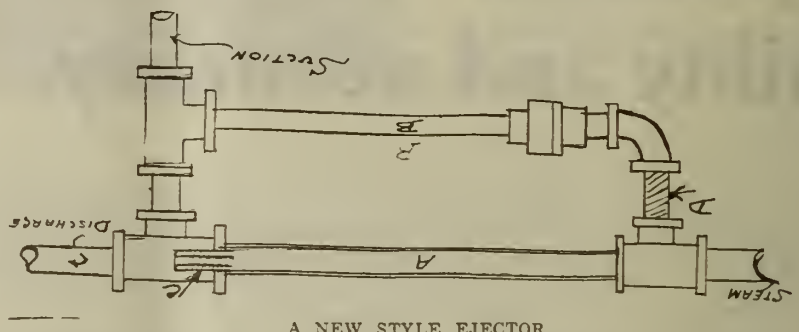
The Operators' Point of View

PUMP SUCTION AIR VESSEL

Much has been written about solving pump troubles, but a feature seldom referred to is the proper location for suction pipe air vessels. In many cases these vessels are placed on the pipe "B" between the pump and the source of supply. It would seem that better results would be obtained by placing the air chamber beyond the pumps, as shown in Fig. 1. An air chamber so placed would have a better chance to check a suction pound than if placed elsewhere as the primary lines of force of the moving water would have a tendency to move past the pump and be cushioned on the entrapped air in the chamber. Possibly a long bend elbow used in place of the tee at "C" would give improved service.

DESIGN FOR EJECTOR

The ejector shown at Fig. 2 has some features not usually found in such apparatus. It can be made in any convenient size. Pipe "A" is a piece of extra heavy pipe threaded internally at one end to take in the piece of iron rod shown. This rod has a hole drilled through it for the steam jet, the diameter of the hole being in accordance with the size of the ejector pipe. For an 1¼ ejector pipe the diameter of the nozzle should be three-eights inch. The piece "D" is also solid. The steam and suction pipe can be flexible, and the ejector can be handled wth comfort by the pipe "B," which also acts as a sort of suction air chamber.

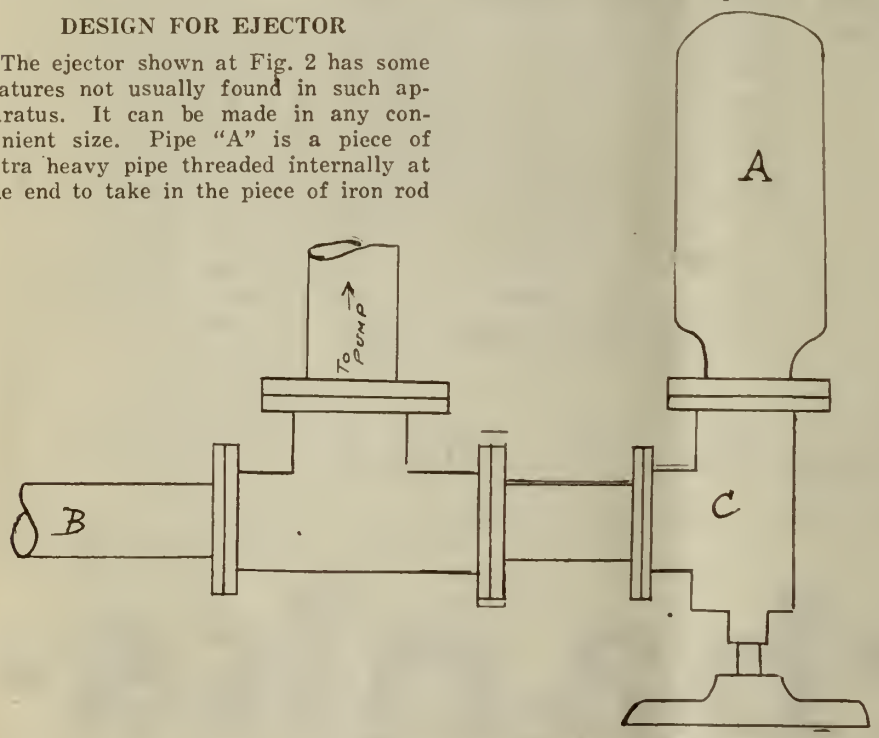


A NEW STYLE EJECTOR.

CHIMNEY CHECK VALVE

The usual cure for a smoking chimney in a domestic furnace is to increase the length of the chimney. The method illustrated here is a departure from the usual, and gave successful results. As a rule, a down draft is only of a few second's duration, though in that time a goodly amount of smoke is forced through the house. The down draft may only occur at infrequent intervals.

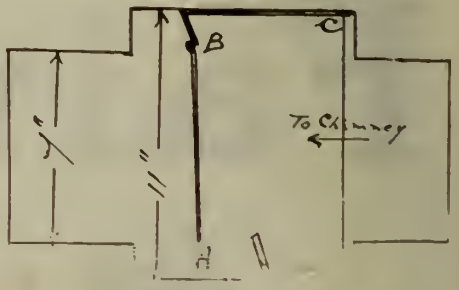
Fig. 1 shows the down draft cure. It is made from stove pipe or galvanized iron. The space around "A" is open and has enough area to allow free exit for the products of combustion. The hinge at "B" is made very slack, to allow perfect freedom of movement, and the furnace pipe can be taken apart from the casing. In the event of a down draft occurring the flap will close, checking the down draft and preventing the smoke being blown out of the furnace. This check, if it achieves the results claimed by the maker, should be a lot less expensive than building an extension on the chimney.



ARRANGEMENT OF SUCTION AIR VESSEL.

REPAIRING PUMP VALVES

Having occasion to repair a pump, I found the valves at the water end in very bad condition. It being impracticable to take them out, it was necessary to find a means of facing up the seats while in place. To do this I took a smooth file, broke a piece about 3 inches long off it, softened it, and made a square hole to take a shank. This shank was made to fit a common brace. The file was then turned round on the seats, and after taking a preliminary cut, another piece of file was used with the edges ground off like a scraper.



CHIMNEY DRAFT CHECK

This finished them up, and each seat only took about ten minutes' work, and a perfectly good job resulted.

ERNEST V. BELL.

The Stability of Dunham Standards

The experimenting which determined the principle of the Dunham Radiator Trap ended twenty years ago. Refinements in its appearance have, of course, been made since it was placed on the market, but improvements here and there have only accentuated the ideal principle on which it operates.

The basic principle of the Dunham Radiator Trap is one involving the laws of thermodynamics. The permanency of this principle makes unnecessary any juggling with the purely mechanical side of the trap.

Permanency in mechanical construction is vital also. The best proof we know of is that furnished by eighteen-year-old Dunham Traps operating to-day, with promise of keeping at it indefinitely. Much of that can be credited to the honest craftsmanship of eighteen years ago—and to this standard we adhere to-day, in what is said to be one of the finest industrial plants in Canada.

In using Dunham Radiator Traps and other Dunham products, you place your confidence in standards that have matured, that will never be sacrificed to commercial expediences.

Full details of the Dunham Trap, and the other Dunham specialties, will be sent on request.

DUNHAM SPECIALTIES

Packless Radiator Valves
Radiator Traps
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Vacuum Pump Governors
Reducing Pressure Valves
Oil Separators
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Air Vents
Return Traps
Check Dampers
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Condensation Pumps

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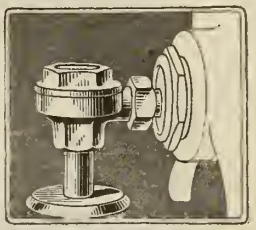

Dunham Radiator Trap

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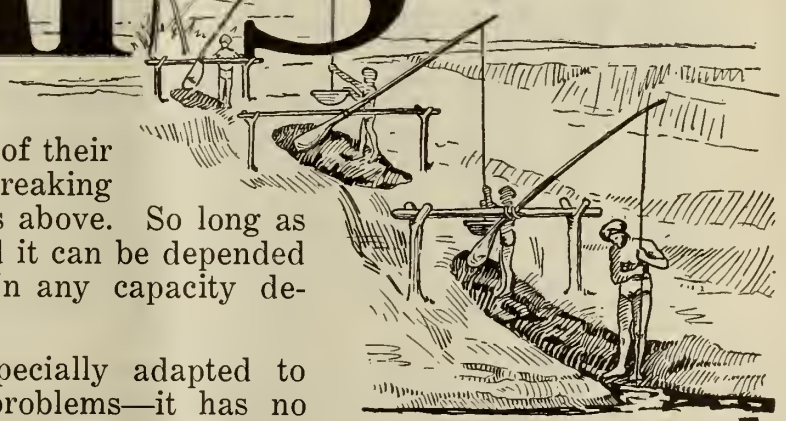
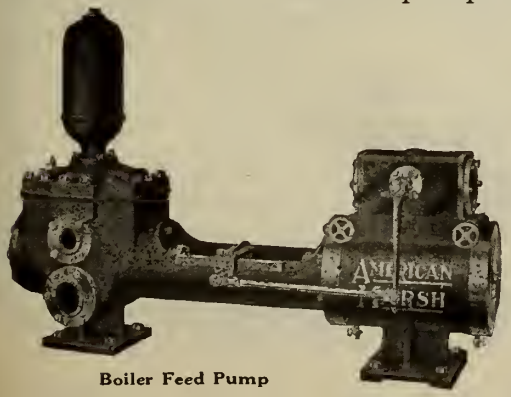
PUMPS

The Egyptian Shadoof relays the water of the River Nile from one well to another until the heights above are reached.



Just as long as the dusky Egyptians continue to dip, dip, dip—to the tune of their monotonous "pumping" song—the creaking Shadoof carries the water to the hills above. So long as an **American-Marsh** Pump is operated it can be depended upon for splendidly efficient work—in any capacity desired.

The **American-Marsh** Pump is especially adapted to the solution of difficult pumping problems—it has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design.



Boiler Feed Pump

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Battle Creek, Michigan

Chicago Office:
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A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	29 50
1¾-in.	29 75	27 00
2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
3½-in.	63 50	43 50
4 -in.	85 00	55 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$5 25	$5 25
Plates, ¼-in. up	4 75	4 75

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

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4½-in. and larger, 40%.

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Standard couplings, 4-in. and under, 20%.

4½-in. and larger, 20%.

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Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 87½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

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Vulcan	50
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Black Diamond	27½
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McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

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Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
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Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7-16 and over	—5
Machine bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
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Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

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Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
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Bars, ½ to 2-in.	$32 00	$34 00
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Standard	10%
Best grades	15%

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XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13½
X L C R	14½		

Colored

Lion	13½	Popular	10½
Standard	12	Keen	9
No. 1	14		

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Arrow	35	Anvil	22
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Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$39 00	$40 00
Spelter	7 75	7 50
Lead	5 75	7 50
Antimony	8 00	8 25
Aluminum	34 50	30 00

Prices per 100 lbs.

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Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.

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Because he knew that it gave such long service even under hard conditions, and it would save him unnecessary labor and make for operating economy.

WHY DID THE PURCHASING DEPARTMENT SEND AN IMITATION?

Because they could buy it for less money and failed to take into consideration the greater quantity used and increased labor expense of frequent repacking.

Buying on price rather than quality is usually expensive in the end, especially so of packing, as the labor expense of applying it is much more than the cost of the packing itself, so that the quality that gives long service saves labor expense and is therefore more economical.

The Purchasing Department makes a great mistake when it fails to buy on a quality basis.

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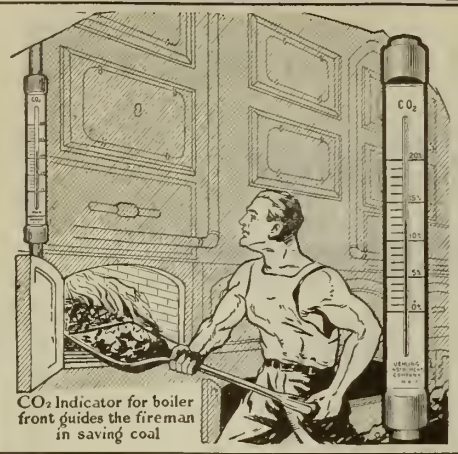

CO_2 Indicator for boiler front guides the fireman in saving coal

The Big Boiler Room Waste

is the heat discharged up the chimney

UEHLING CO_2 EQUIPMENT

keeps tabs continuously (not intermittently) on this waste, thus enabling engineer and firemen to co-operate in reducing it. Uehling CO2 Equipment is simple in principle and operation and uses no chemical solutions.

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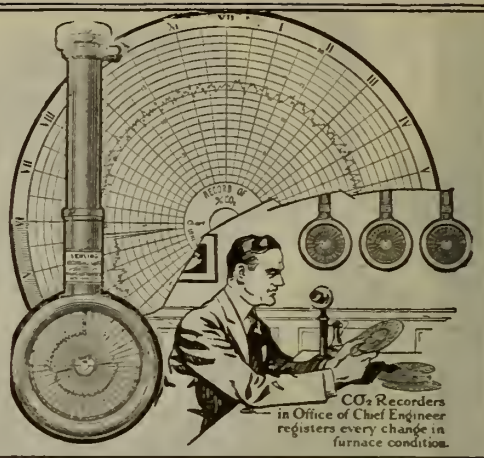
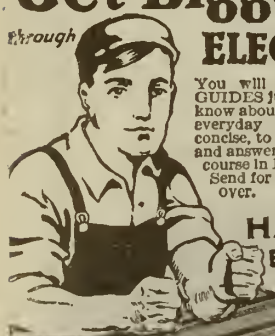
Combustion Engineers

2008 Empire Bldg. - New York


CO_2 Recorders in Office of Chief Engineer registers every change in furnace condition.

Get Bigger Pay through ELECTRICITY



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STEAM ENGINES, BOILERS, HEATERS, tanks, stacks, pumps and condensers, transmission and elevating machinery, safes, vaults and vault doors; catalogue and specifications sent on request. Apply, mentioning "Power House," to Goldie & McCulloch Co., Ltd., Galt, Ont. (pfh)

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BOILERS AND POWER PLANT EQUIPMENT bought by the Henry Engineering Company (Henry-Rumgay-McBryde), 71 Bay St., Toronto. Mention "Power House." (pfh)

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POSITION WANTED BY AN EXPERIENCED refrigerator engineer, also competent in ice making and electricity. Address, D. M. J., Power House, Toronto. (p1h)204

STATIONARY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers. Corliss and all classes of stationary engines, compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St., Toronto. (pfh)

MECHANICAL ENGINEER, 29, FIRST-CLASS stationary engineer's license for Ontario, 10 years' power plant experience, saw-mill and paper mill; specialist in making repairs and operating plant economically, desires permanent position with large saw-mill or paper mill, preferably in New Ontario. Apply to Box 202, Power House. (pfh)

NON-CORROSIVE CYLINDER OIL

MANUFACTURED ONLY BY E. H. KELLOGG & CO. NOS. 242-244 SOUTH ST. NEW YORK, U.S.A.

FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

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Does your chimney need repairing? Experienced chimney foreman and expert repair man is open for engagements. Put your problems up to me. Rates reasonable.

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Engineers, Manufacturers and Founders

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Special Castings *Forgings*

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THE unusually broad face of the segment and the corresponding broad face of the pinion reduce wear on the teeth to a minimum in American gauges.

The segment itself is made of specially hard cast bronze, while the shafts and bushings of both segment and pinion are made of the same wear-defying metal. Both segment and pinion shafts also rest in phosphor bronze bushings to further reduce wear.

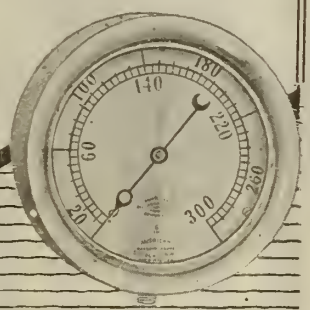
AMERICAN IDEAL STEAM TRAP

All the way through they are built to withstand the most exacting service.

Which is another way of saying that these accurately constructed gauges RETAIN THEIR ACCURACY long after ordinary gauges are worn out.

Another thing that insures ACCURACY is that each dial is hand-calibrated—each one designed particularly for the gauge on which it is applied.

May we send you a copy of Catalog No. 70.



The American Steam Gauge & Valve Mfg. Co.

BOSTON, MASS.

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SAFETY PLASTIC

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For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

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Drop us a line and let us tell you all about this remarkable packing and our "Safety" Superheat Sheet Packing.

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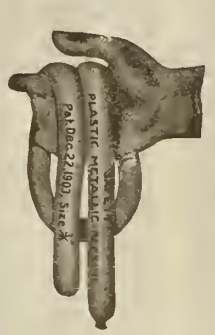
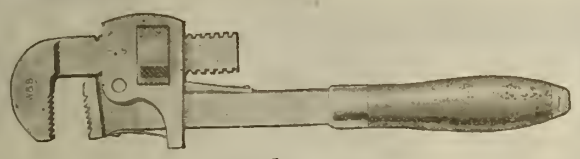


In Cotton Tubes



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WILLIAMS' Stillson Wrenches

there is nearly half a century's experience in the manufacture of superior drop-forged tools.

Made in two models—wood and steel handle—and in 8 sizes from 6 to 48 inches, with capacities from ⅛ to 5 inches. At your dealer's. Literature on request.

J. H. WILLIAMS & CO., LIMITED

"The Wrench People"

Formerly Canadian Division of The Whitman & Barnes Mfg. Co.

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Extravagance Must Stop!

THE COPES Boiler Feed REGULATOR

is a vital organ in the system which draws the latent energy out of the coal pile and delivers it at the bus bar or the main drive shaft.

Without the Copes Boiler Feed Regulator none of the other organs can perform its function properly. Stokers, feed water heaters, water softeners, and the boilers themselves cannot do their best without proper feed water regulation. The legibility of steam and water flow records, pressure and temperature charts, all depend more or less on scientific feed water regulation.

For complete information about COPES BOILER FEED REGULATORS, ask for Bulletin D.

Northern Equipment Co.

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The World's Largest Manufacturers of Feed Water Regulators

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W. W. HICKS & CO., 567 Banning St., Winnipeg, Canada.

108

Check the Dollars You Burn!

Do you know how many of the dollars you burn are actually invested in heat—and how many are wasted?

Of course you know how many tons of coal you buy. And you probably know how much heat that coal contains—you can get a B.T.U. analysis from any chemist. But do you know the amount of heat you get out of that same coal?

There is only one dependable way to calculate the value of your coal—what quantity of water is evaporated by a ton of it? A

YARWAY-LEA V-Notch METER

will give you the records you need to determine the degree of economy with which your boiler room is operated and will enable you to prove this to the management. It is a simple, durable, scientific machine, providing permanent records guaranteed accurate within 1½% at high and low rates of flow.

There are many other uses for the Yarway-Lea Meter beaidea in the boiler room.. Booklet L-40 goes into details. Where shall we send your copy?

Yarnall-Waring Company
7604-20 Queen Street
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Representatives in all Principal Cities

Also Makers of

Yarway Seatless Blow-Off Valve.
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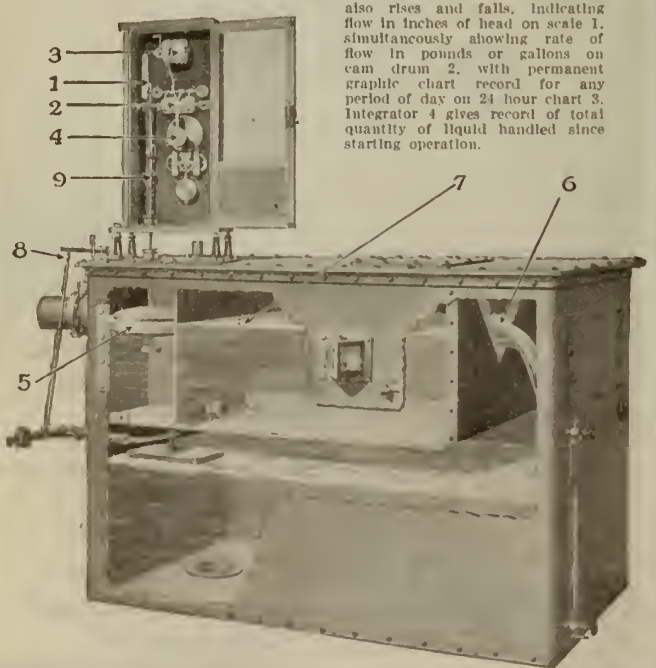
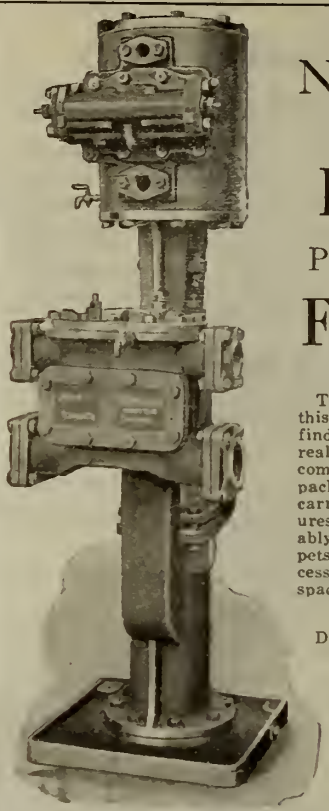
Yarway Adjustable Spray Head.

YARWAY-LEA V-NOTCH METER

Operation: Liquid is admitted through control valve 8 to weir chamber 7. As liquid rises and falls, V-notch 6, float 5 connected to rackrod 9 also rises and falls, indicating flow in inches of head on scale 1, simultaneously showing rate of flow in pounds or gallons on cam drum 2, with permanent graphic chart record for any period of day on 24 hour chart 3. Integrator 4 gives record of total quantity of liquid handled since starting operation.





NO EXCUSES
With the
HEPBURN
Patent Vertical Ram
FEED PUMP

There are no excuses attached to this Hepburn Patent Pump. You'll find that out if you give it some real work to do. It is a sturdy, compactly constructed, outside packed type for Feeding Boilers carrying the highest steam presures. The construction is remarkably simple and eliminates all tappets and levers. Every part is accessible, and it takes little floor space in the Power House.

Duplex Pumps, Vertical Engines, Compressors, Hand and Electric Overhead Cranes for Power House Service are also products of the Hepburn plant.

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET, TORONTO, CANADA

As Easy as Renewing a phonograph needle

Would you buy a phonograph, so constructed that it required an expert mechanic to take it apart every time it needed a new needle? Then why put up with valves that require removal from the line, or at best call for considerable skill, tools and devices, whenever the disc becomes worn from hard use?

It takes but a minute or two to replace a worn disc in a PRATT & CADY RENEWABLE DISC GLOBE VALVE. In a jiffy you unscrew the bonnet and slip a new asbestos disc onto the end of the spindle. The very simplicity of construction adds rugged atrength and long life to Pratt & Cady Valves and Renewable Discs. Here is a sure way to reduce your maintenance costs!

Learn more about it. Send for our free valve book.

PRATT & CADY CO., INC.

Manufacturers of Valves and Asbestos Packed Cocks that give long and satisfactory service.

Factory, Hartford, Conn.

The Canadian Fairbanks-Morse Co., Ltd., Halifax, St. John, Quebec, Montreal, Ottawa, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

PRATT & CADY
RENEWABLE DISC GLOBE VALVES

How to Solve Your Bearing Problems

The cheapest and most reliable form of insurance against interrupted production from worn out bearings is to have on hand in your own shops several bars—in sizes to meet your needs—of

MUELLER BRONZE BEARING METAL

These bars contain high percentages of copper and tin, giving a tough, close-grained casting to stand high speeds and heavy pressure. We carry a full assortment of Mueller Solid Bars from ½ in. O. D. to 4 in. O. D. in lengths of 12 ins.; in Mueller Cored Bars all sizes from 1 in. O. D. x ½ in. I. D. to 4 in. O. D. x 2¼ in. I. D.; all in lengths of 12 ins. Complete list of sizes and prices will be furnished on request. Mail orders given prompt attention.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.

KEEP YOUR BOILERS CLEAN
TO SAVE FUEL

⅛-inch Deposit on Tubes Increases Coal Consumption 30%
¼-inch Deposit on Tubes Increases Coal Consumption 66%
½-inch Deposit on Tubes Increases Coal Consumption 150%

MILLER'S BOILER CLEANING EXTRACT

Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

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What Keeps this Country Fit to Live In?

Mason Standard Bronze Reducing Valve.

IS IT not safety devices? Think of some you depend on every day. Safety vaults, alarm signals, lights, fire escapes, and hundreds of others. To the power house engineer

MASON DEVICES

fulfill identical purposes. Mason Reducing Valves and Regulators, Bundy Steam Traps and Reilly Water and Grease Appliances are a constant insurance of free-from-worry service and an absolute guarantee of reliability and positive action.

Write us for particulars.

New Bundy Return Steam Trap.

Reilly Feed Water Filter and Grease Extractor.

The Mason Regulator & Engineering Co., Limited
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Garlock Packings

Have you ever considered the loss in engine efficiency due to excessive friction on piston and valve rods caused by the use of inferior and poorly lubricated packing?

A horse power easily can be absorbed at the stuffing box and, when considered in dollars and cents at the coal pile, the loss would pay for a high class packing many times over.

Garlock packings are designed to meet every condition of service.

Write for Catalog.

The Garlock Packing Company

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BRANCHES:

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Lascar V Packing

CONSISTS of a single V-shaped bar of white metal securely fastened in its cushioning of highest grade asbestos. The packing is extremely flexible and exactly takes the shapes of all rods, and having a continuous bearing surface of white metal reduces friction on the rods to a minimum. This packing is particularly adapted for the highest steam pressures and has the advantage of great durability, consequently saving much time and labor in constantly replacing glands.

Made in sizes from 5/8" up.

BELDAM ASBESTOS (CANADA) COMPANY

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IF IT'S MADE OF ASBESTOS WE CAN SUPPLY IT

Steam — Steam — Steam!

¶ No business can do without it—either in a literal or a figurative sense.

¶ The shop that doesn't improve or renew its Boiler equipment now is losing a valuable opportunity — our service is at its best and new, low prices are available.

¶ We make every type of Boiler, steel plate work, castings, etc.

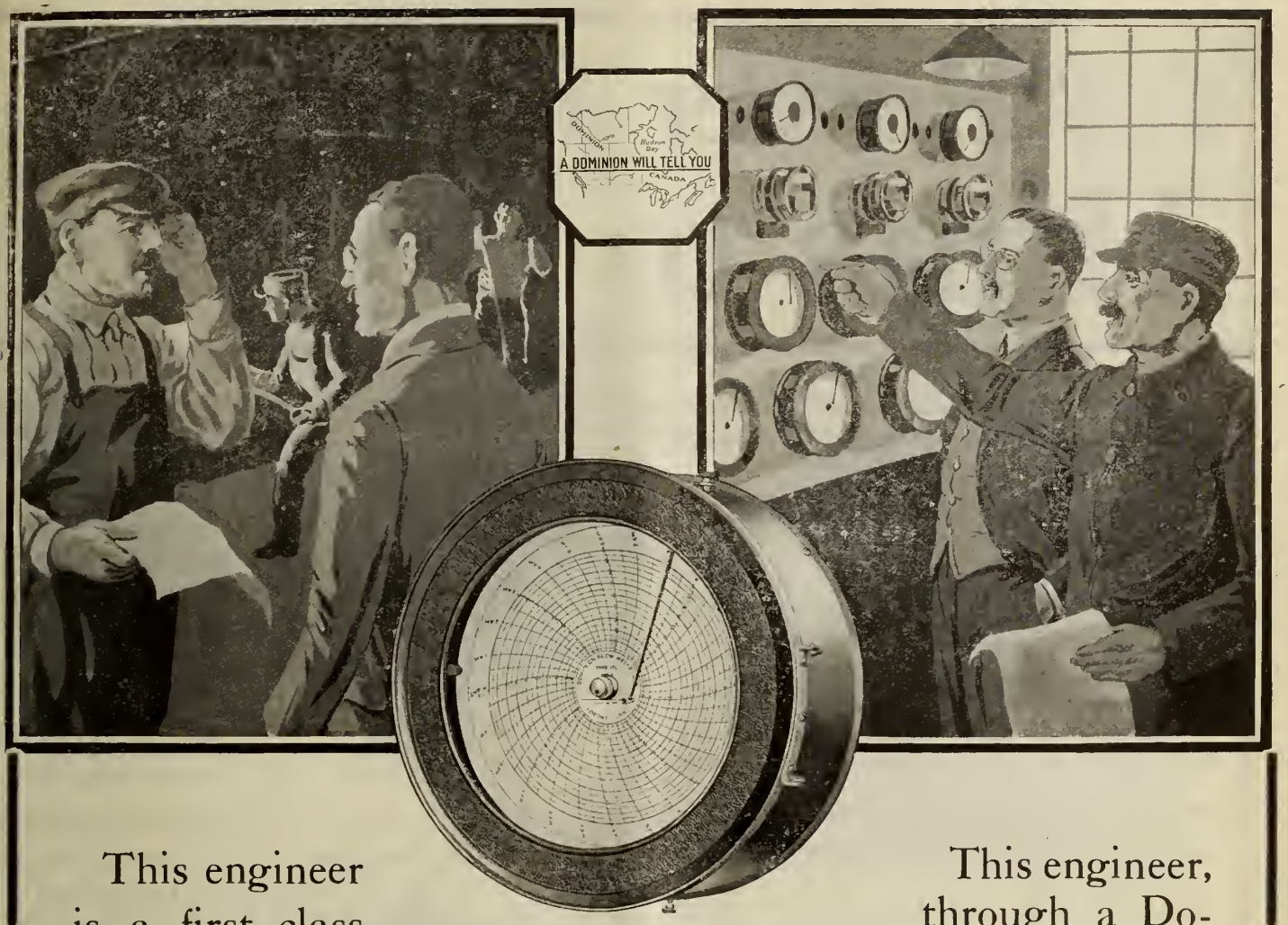
¶ Write us to-day.

Our Boiler Shop—"going strong"

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices:
HALL MACHINERY CO., Sherbrooke, Que., and Birks Bldg., Montreal



This engineer is a first-class man of long experience, but when the office wants data on the efficiency of his boilers and distribution of the steam he is admittedly guessing.

This engineer, through a Dominion metered steam plant, can give data at all times as to steam production and distribution. As a result, he obtains the maximum efficiency of his plant.

Have You Accurate Knowledge of Your Steam Plant?

You cannot improve your conditions unless you know what your conditions are.

"A Dominion Will Tell You"

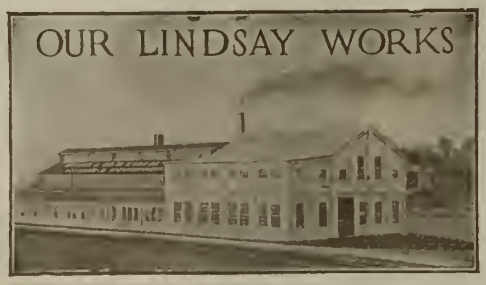
Dominion Flow Meter Co., Limited

DEPARTMENT M

145 West Wellington Street, Toronto

"Power House" Hints to Buyers

Water Turbines, Hydraulic Governors, Centrifugal Pumps



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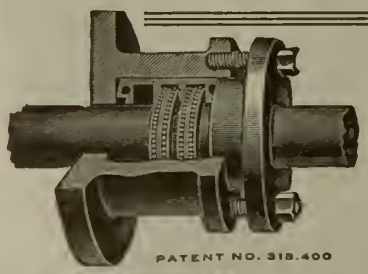
Lindsay, Ontario



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	634,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	726,366	" "	895,791
" "	774,490	" "	898,066
" "	776 193	" "	906,108
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Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

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127-147 Thirteenth Street, ELKHART, Ind., U.S.A.

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operating Gravity - Filled Bottom Dump Bucket by Monorail or Cableway.

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McDaniel Improved STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

Send for Catalogue

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WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Trial Orders Solicited—Our Packings Do the Rest

Insist Upon Having the TRADE Packing Bearing Our MARK

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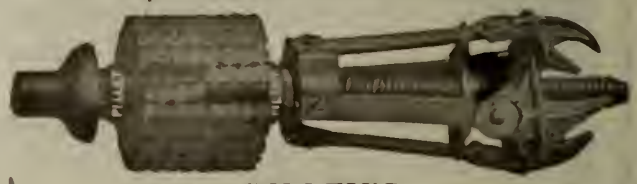
Stocks carried in all sizes TEL. No. MAIN 2387

The Simplest and best cleaner on the market is



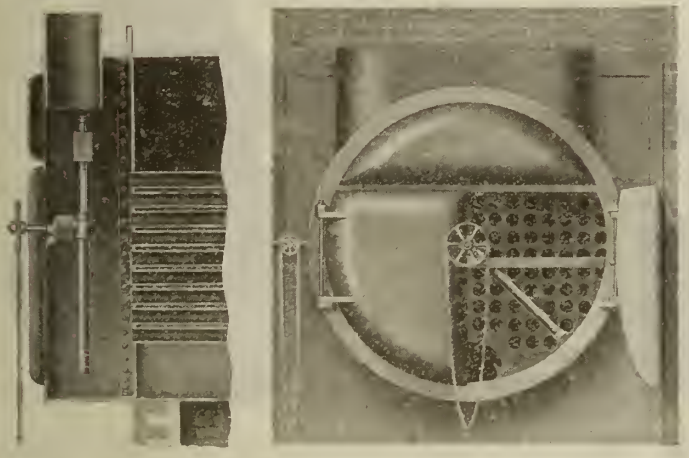
PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

The appalling waste of coal in the operation of Return Tubular Boilers



Some years ago the Engineering Department of the University of Illinois conducted a test of Vulcan Soot Cleaners in Return Tubular Boilers.

For 5 days they allowed soot to accumulate; then 5 when tubes were cleaned daily; then 5 more of no cleaning. The result of that test was conclusive evidence that most Return Tubular boilers, not equipped with soot cleaners, waste an appalling quantity of coal.

The test showed an increase in evaporation due to clean surfaces of 13%. It indicated a DECREASE in coal burned per square foot of grate per hour, due to clean surfaces, of 32.16%. It showed a lowering of stack temperature, due to clean surfaces, of 17.59%.

It is plain that maximum evaporation and minimum coal consumption don't go together when the tube surfaces are heavily coated with soot—a perfect insulator, the most efficient dissipator of heat known! It is obvious that the soot must not merely be removed OCCASIONALLY, as is done with the hand lance, but REGULARLY, at stated intervals, as is done by the Vulcan Cleaner. Without this regular cleaning, soot has time to build up, retard evaporation and increase coal bills.

The owner of Return Tubular boilers that are not equipped with Vulcan Soot Cleaners may take it for granted, therefore, that he is paying for this equipment many times over yearly in lowered efficiency and unnecessary coal wastage.

Ask for a copy of our folder "SPENDING $796 TO SAVE $1,017.40." It is a revelation to the plant owner and engineer of the tremendous possibilities of Vulcan Soot Cleaners as dividend-paying producers.

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES

WINNIPEG
Wm. W. Hicks & Co.,
567 Banning St.

TORONTO
Green's Economiser Ltd.,
Kent Building

BAILEY Boiler Meters

Simple Yet Comprehensive

For efficient operation the Steam Flow and Air Flow records come together and show as a single record. When excess air is entering the furnace, the Air Flow record shows above the Steam Flow. The opposite is true when the coal feed is too great and the fires are not receiving sufficient air.

The record of the Flue Gas Temperature made on the same chart indicates the relative condition of the baffles and tubes. The Fire Box Draft is indicated for assistance in maintaining balanced draft conditions.

Bulletins upon request

Bailey Meter Company
2001 E. 46th St., Cleveland, Ohio

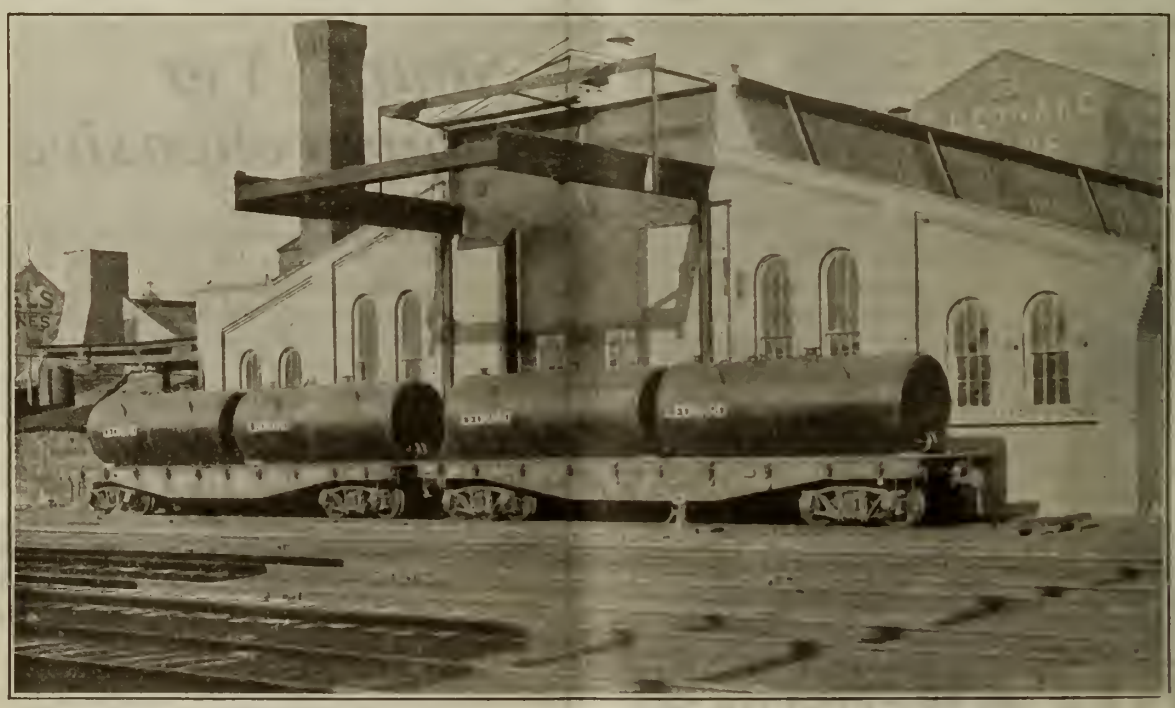
KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**



Shipment of Four 150 H.P. (72 in. x 18 ft.) Return Tubular Boilers for 150 lbs. working pressure. January, 1921

Established 1834.

Head Office and Works, London, Canada

Toronto Reps.—ARTHUR S. LEITCH CO., Limited, 1001-2 Kent Bldg., TORONTO

LEONARD

STOP !

Don't Throw Away Your Fuel

In the average power plant one shovel of coal in five is wasted. One-fifth of all the fuel burned under boilers operating on saturated steam is thrown away without getting the full value out of it.

Repairs, replacements, labor and similar items involve the expenditure of thousands of dollars annually; an expense that should be reduced and which can be reduced by the application of

ELESCO SUPERHEATERS

ELESCO Superheaters save fuel—often one shovel in five. They reduce maintenance costs by increasing boiler capacity, making possible the operation of boilers at lower ratings. Water hammer with its destructive costly repairs is eliminated, because superheated steam, being dry, carries no water into steam lines and engine cylinders.

An estimate of what ELESCO Superheaters will accomplish in your plant will disclose savings which you may never have considered possible—savings which will return the first cost of the installation in a few months.

May our engineers assist you?

Have you a copy of Bulletin NT-7. If not, send for it to-day.

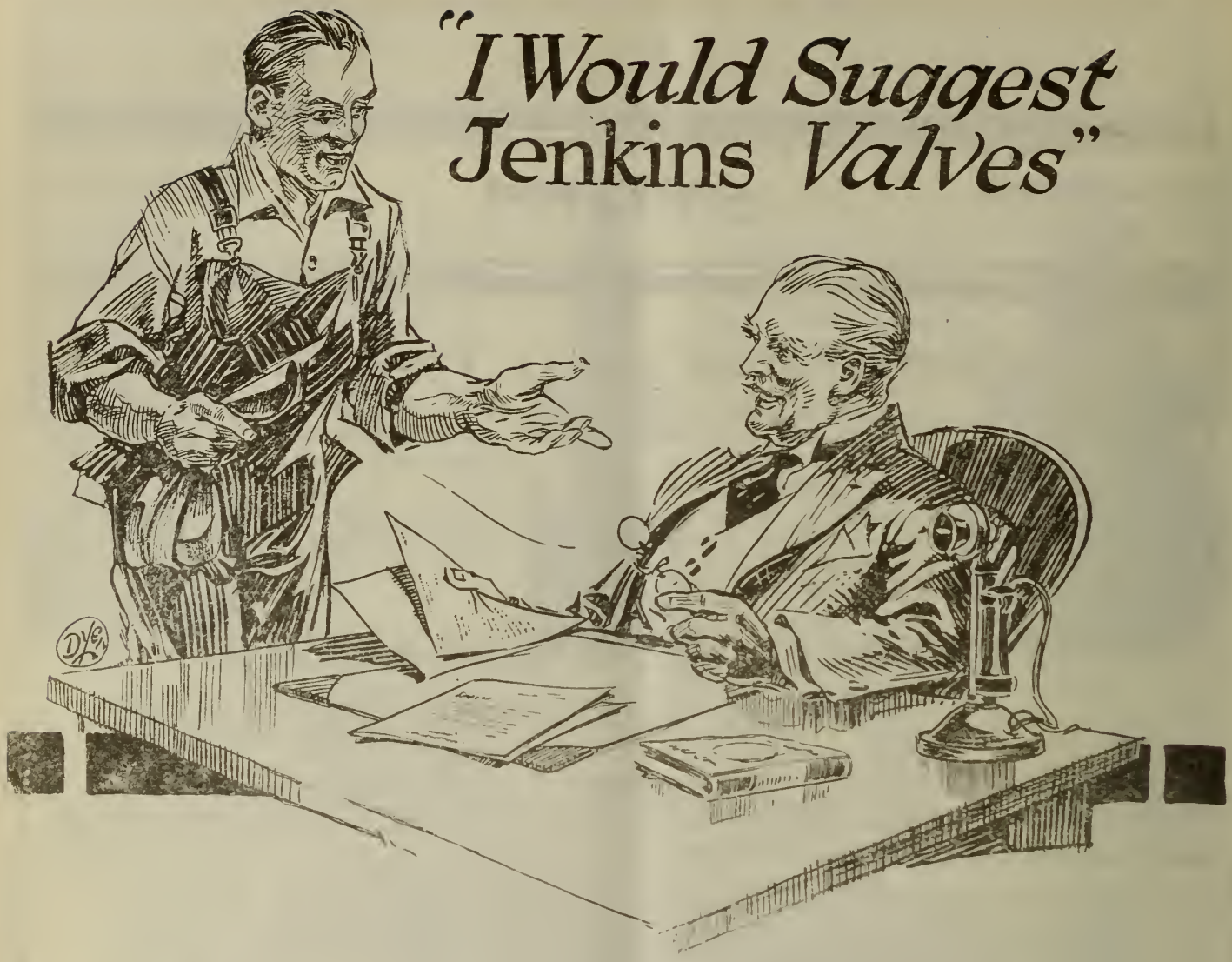
The Superheater Company, Ltd.

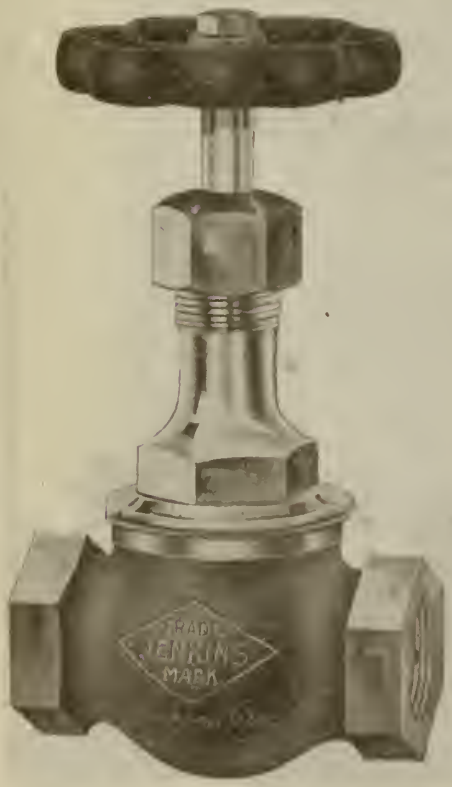
Transportation Building, MONTREAL
Works at SHERBROOKE, Que.

British Columbia Representatives
THE TAYLOR ENGR. CO., LTD.
Vancouver, B.C.

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all purposes.

"I Would Suggest Jenkins Valves"





WHEN the inevitable breakdown—occasioned by inferior valve equipment—occurs, the Engineer who knows valves and valve requirements will invariably suggest Jenkins Diamond-Marked Valves.

Unpleasant reminders do not follow the installation of Jenkins Valves. Made strong and heavy and made of the best brass, iron or cast steel, they remain dependable and unaffected when subjected to the strain of hard usage and severe service.

Jenkins Diamond-Marked Valves are made in a size and a style to completely control the passage of steam, water, air, gas and other liquids or vapors.

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THE big industrial plants of the country are operated for profit. Although they render a service of great importance to the entire population, their very existence, to say nothing of their growth and development, depends upon their ability to pay dividends on the capital invested in them.

This means that every phase of their operations—buying, producing and selling—must be carried on in the cheapest manner compatible with the character of the business. The big corporations scrutinize every operation with reference to its relation to dividends. This is particularly true to-day with regard to costs of power.

Cheap power means cheap factory costs. Cheap factory costs mean reduced overhead. Low overhead increases profits. Every dollar saved in the coal pile means an appreciable addition to the dividend pile.

Almost without exception the big industrial plants are increasing dividends through the use of Diamond Soot Blowers. They have found that Diamond Soot Blowers effect such economies as—a saving of 4 to 8 per cent. in fuel—increase in boiler efficiency of 3 to 4 per cent.—a material saving in labor, labor turnover, etc.

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Our district offices are listed in the telephone books of all principal cities. If you write us direct, ask for Bulletin No. 280.

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WINDSOR, ONTARIO

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A NEW EFFICIENCY DEVICE

The Time Punch for Columbia Recording Thermometers

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The TIME PUNCH makes a small hole in the time border of the chart *the very second the button is pressed.* It makes the Columbia Recording Thermometer *a time clock* as well as a heat-recording device.

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The TIME PUNCH makes the Columbia Recording Thermometer doubly valuable. The chart gives you a 24-hour record of temperature changes. The TIME PUNCH, by compelling vigilance on the part of the operator, gives you the assurance that definite instructions as to temperature will be carried out! Its use is your protection against losses mounting up to hundreds and perhaps thousands of dollars.

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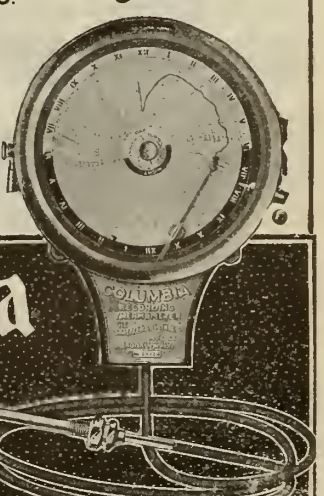

Columbia Recording Thermometers

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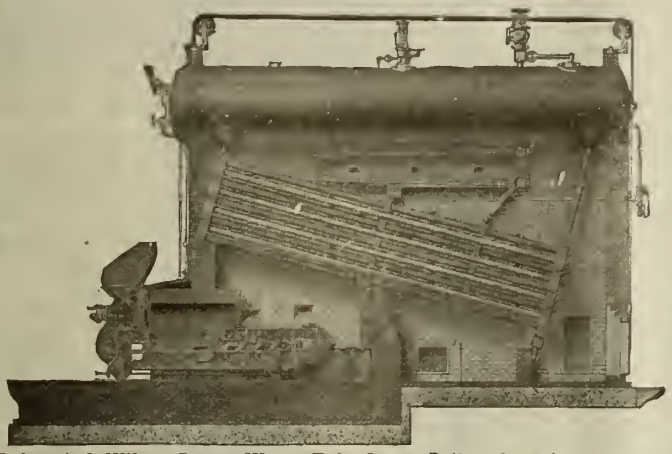

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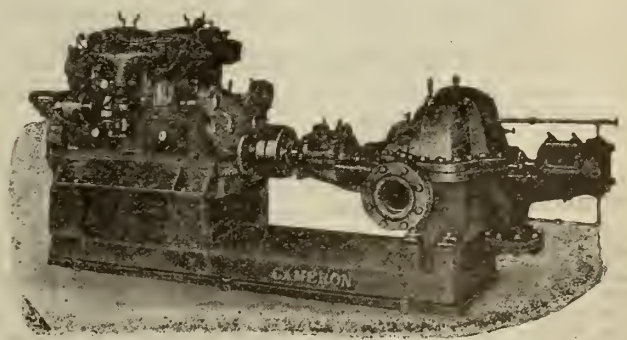

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Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal Que
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Jeffrey Manufacturing Co., Montreal.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
The Jos. W. Hays Corp. Michigan City, Ind.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Borser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd. Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford
Robb Engineering Works Ltd. Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que
Arthur S. Leitch Co., Ltd., Toronto.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y
Jas Morrison Brass Mfg Co., Toronto.

EXPANSION BOLTS
Beveridge Paper Co., Ltd., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Beveridge Paper Co., Ltd., Montreal.
Shell Bar Boiler Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Paper Co., Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK, PLASTIC
Beveridge Paper Co., Ltd., Montreal.
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Paper Co., Ltd., Montreal.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Paper Co., Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.

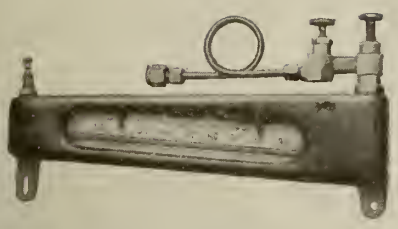
FITTINGS, DRAINAGE
Crane Ltd. Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

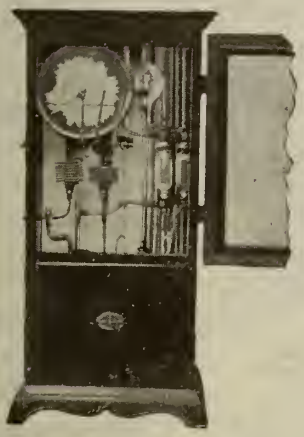
FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Page-Hersey Tubes, Ltd., Toronto, Ont

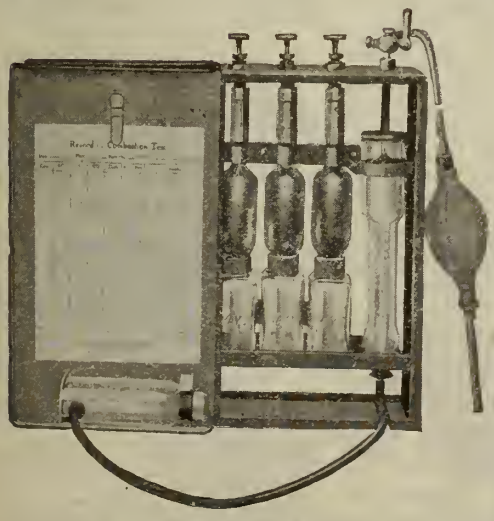


The Hays Draft Gage



The Hays Automatic CO_2 and Draft Recorder

Awarded Certificate of Merit by Franklin Institute.



The Hays Improved Gas Analyzer.

Find the Errors and Correct Them

The way to stop waste of coal is to go to the boiler room where most of it is wasted and eliminate the wasteful practices in operation. Some of them you can see at a glance and stop at once, but there are other persistent hidden ones which you may never suspect until you see their effect, and will never do away with until you have means of knowing of their presence. A Hays record of the draft over the fire and the CO_2 content of flue gases will point out clearly when and why your coal is being wasted and enable you to build up your furnace efficiency.

The Jos. W. Hays Corporation

Combustion Efficiency Appliances

1040 E. 8th St., Michigan City, Indiana

Leaky boiler settings, improper relation between draft and fire thickness, improperly timed firing periods may all sound innocent enough until you realize that they are the very source of coal waste.

You cannot better your conditions until you know what your conditions are

Hays Apparatus

gives you the complete story

Represented in Canada by

Arthur S. Leitch Co., 1001-2 Kent Bldg., Toronto.

Edward A. Robinson, Montreal.

H. N. Brown, New Glasgow, N.S.

Wm. A. Goold, Winnipeg, Man.

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FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Republic Flow Meter Co. of Can., Toronto.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Uehling Instrument Co., New York.
The Jos. W. Hays Corp., Michigan City, Ind.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGE, RECORDING
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
W. J. Wall, Montreal, Que.
John Moncrieff, Perth, Scotland.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, ELECTRICAL—ALL TYPES
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER BELTING
W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y
Green's Economiser, Ltd., Toronto.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

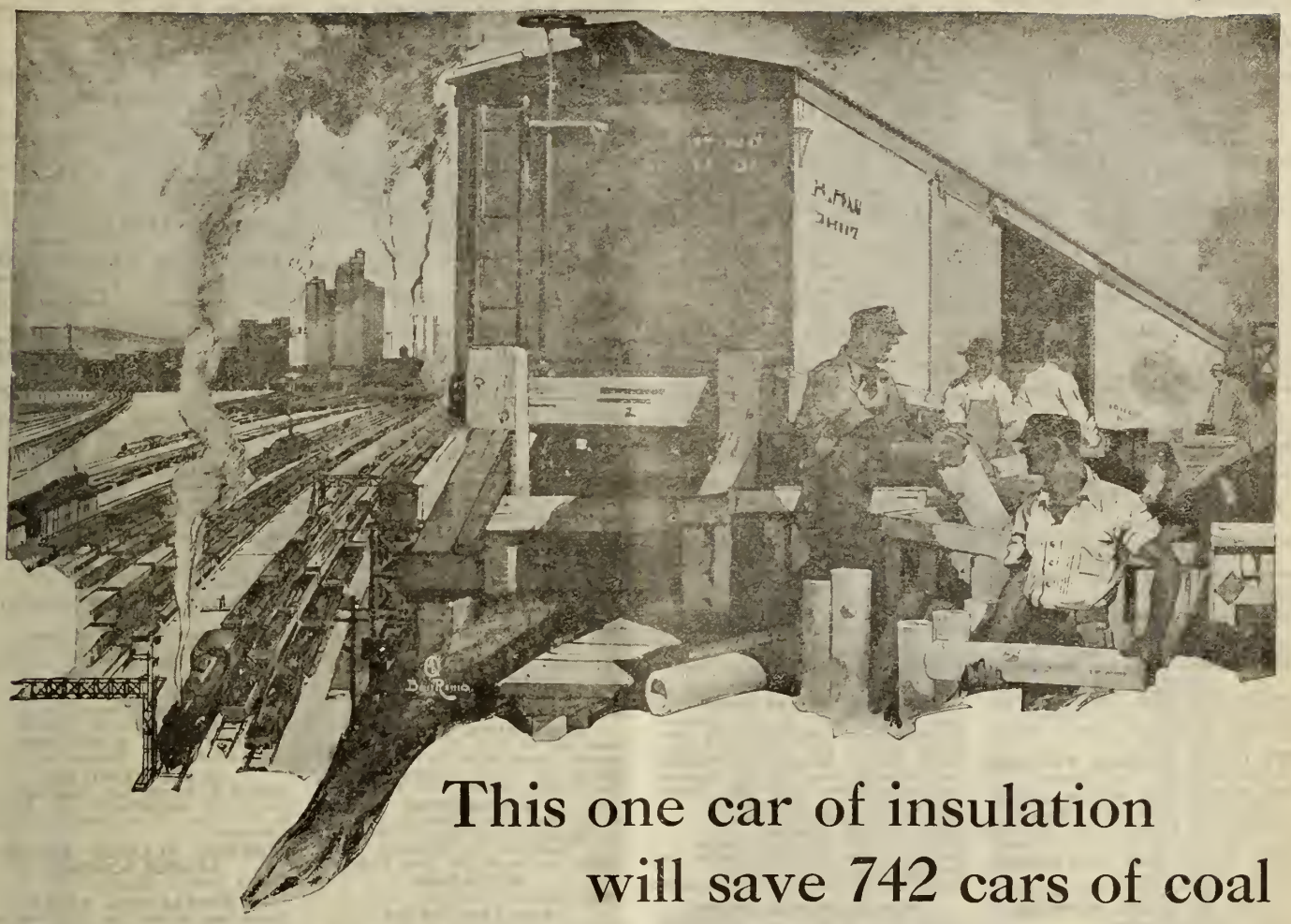
OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton



This one car of insulation will save 742 cars of coal

The Proof:

The life of a felted insulation like Asbesto-Sponge can be conservatively figured at twenty years. A standard 36 ft. car carries 1680' of 8" and 1680' of 4" pipe insulation packed inside the 8"—thickness 1½". With steam pressure at 100 lbs. and air temperature at 70° the efficiency of the 8" is 90.3% and the 4" is 88.9%, thus saving in 20 years 37,100 tons of coal or 742 fifty-ton cars. Savings on Johns-Manville 85% Magnesia can be similarly predetermined.

Other insulations for other services: Asbestocel, Zero, Anti-Sweat and Ammonia Insulation. Underground Conduit Insulation and Insulating Cements.

WHEN you see men handling insulation, you need not wonder what they are going to do with it—you know they are going to SAVE FUEL — and furthermore, you can know exactly *how much* fuel they will save—for the hit-or-miss stabs of the old "pipe covering" days have given way to a modern science of insulation for pre-determining saving and applying these figures in cost of power in the plant or heat in the home.

If coal were cheap and easy to get—and insulation were expensive and hard to get—then bare steam surfaces or plain pipe covering might be countenanced. But in times like these, INSULATION is a vital thing.

The heat losses through pipe covering you may have installed in the days when you didn't need to get down to brass tacks in saving fuel can be figured for you. Such figures compared with Johns-Manville charts will point out the difference between what heat you now save and what you can save through the most efficient commercial insulations obtainable—whether it be Johns-Manville 85% Magnesia of the molded type or Asbesto-Sponge of the strong built-up Felted Type.

Figures shown at the left indicate the millions of dollars saved by Johns-Manville Insulation Service in determining the insulation that is right for you—and applying it for you in the right way.

CANADIAN JOHNS-MANVILLE CO., LIMITED

Toronto Montreal Winnipeg Vancouver London
Hamilton Ottawa Windsor

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

INSULATION *that keeps the heat where it belongs*
CEMENTS *that make boiler walls leak proof*
ROOFINGS *that cut down fire risks*
PACKINGS *that save power waste*
LININGS *that make brakes safe*
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Paper Co., Ltd., Montreal.
W. J. Brown (Tucks), Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgb, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ort.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Arthur S. Leitch Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Inglis Co., John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont
Can. Detroit Lubricator Co., Walkerville
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Hays Corp., Michigan City, Ind.

RECORDEDS CO2
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York
Uehling Instrument Co., New York, N.Y.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 33 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Paper Co., Ltd., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leiteb Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

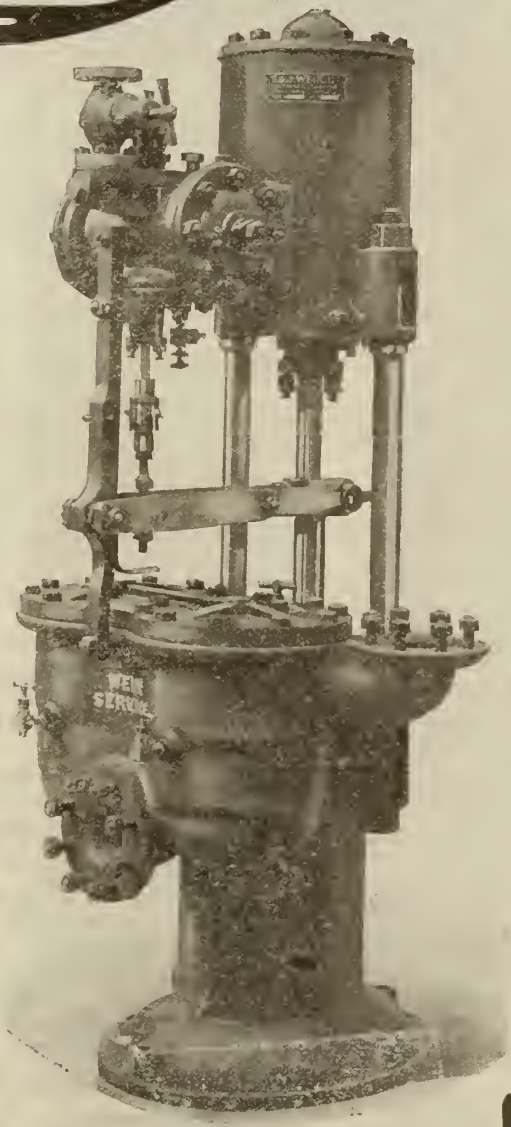
SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

WEIR AUXILIARIES

Single Acting Simplex Feed Pumps
Turbine Rotary Feed Pumps
Compound Feed Pumps
General Service Pumps
Direct Contact Heaters
Multiflow Heaters
Evaporators and Distillers.



PRESTIGE

The steady, confidence-inspiring service of 65,000 Weir Pumps, all over the world, is daily maintaining the international prestige of all products marked "Weir."

Watch a Weir Pump at work. Its slow, even, powerful strokes will convince you that it is accurately designed and properly made for long, efficient service.

In addition to Weir standard pumps there are a large variety of designs for special duties. For high duty installations, for water or oil, we can supply special patterns, simple, compound or triple, for pumping against pressures up to 1,000 pounds per square inch.

Special attention is paid to the prompt dispatch of goods and the routing and shipment of all consignments. Special instructions in this regard always receive our most careful attention.

Prompt and careful shipment is but a single phase of Weir Service. To serve our customers in every way to the best of our ability is our aim.

G. & J. WEIR (Canada) LIMITED

Sales Engineers

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Branch Offices at Lumsden Building, Toronto; Pacific Bldg., Vancouver

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Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

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Bailey Meter Co.

STEAM CALORIMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
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Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can.. Ltd., Toronto

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Hamilton Co., Wm., Peterboro, Ont.

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Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, inc., New York.
Smart-Turner Machine Co., Hamilton.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

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The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM SHOVEL
The Superheater Co., Ltd., Montreal.

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Waterous Engine Works Co., Brantford.

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Mason Reg. & Eng. Co., Ltd., Montreal.
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Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
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York Manufacturing Co., York, Pa.

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Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
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MacKinnon Steel Co., Sherbrooke, Que.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

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Lincoln Electric Co. of Can., Ltd., Toronto

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Taylor Instrument Co., Rochester, N.Y.
Tenling Instrument Co., New York, N.Y.

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Northern Electric Co., Ltd., Montreal.

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Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville

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Darling Brothers, Montreal.
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Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

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Mason Reg. & Eng. Co., Ltd., Montreal
Coppus Eng. & Equipt. Co., Worcester
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
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Dart Union Company, Toronto.
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Dart Union Company, Ltd., Toronto, Ont

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H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company, Toronto.
Homestead Valve Mfg. Co., Pittsburg
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Pratt & Cady, Hartford, Conn.
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Pratt & Cady, Hartford, Conn.

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Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

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Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
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Can. Fairbanks-Morse Co., Ltd., Montreal

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Penberthy Injector Co. Windsor, Ont.
Pratt & Cady, Hartford, Conn.

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York Manufacturing Co., Philadelphia.
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Mason Regulator & Eng. Co., Montreal.
Sarco Company, Inc., New York.

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Arthur S. Leitch Co., Ltd., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.

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Pratt & Cady, Hartford, Conn.

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Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

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WASTE
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Electric Welding Co., Montreal.

WELDING SUPPLIES
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WIPERS
R. C. Miller Oil & Supply Co., Ltd., Montreal

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
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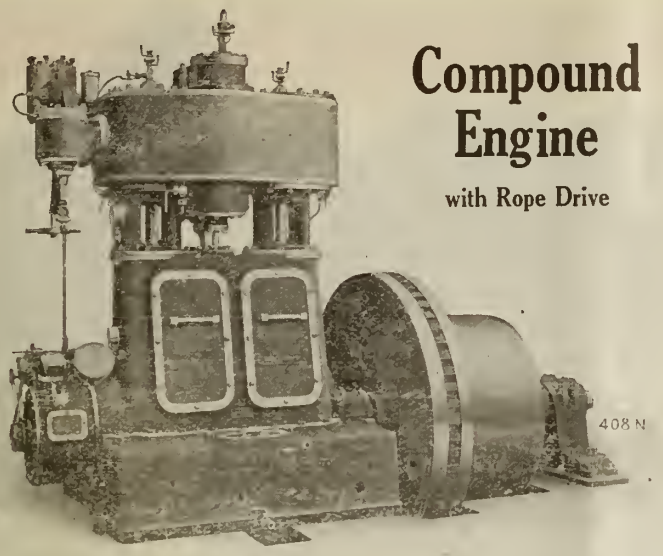


Compound Engine

with Rope Drive

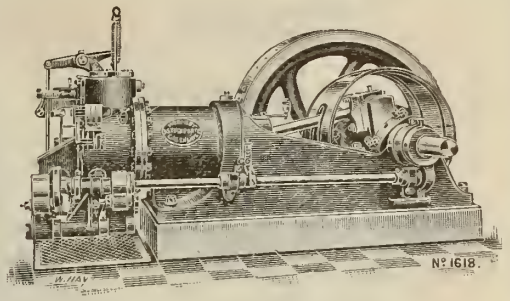
BELLISS & MORCOM, LTD.

Birmingham, England

Builders of

Steam Engines
Steam and Exhaust Turbines
Air Compressors
Crude Oil Engines
Condensers

LAURIE & LAMB Board of Trade Building Montreal



Hornsby Gas Engine

RUSTON & HORNSBY LTD.

Lincoln, England

Gas Producers using lignite waste wood, sawdust, etc.

Cold Starting, Airless Injection Oil Engines.

Simplest construction, highest efficiency

Oil Locomotives.

Duval's Metallic Packing

Semi-metallic Packing for Centrifugal Pumps.

How to Test Advertising

THE man who doubts the power of advertising belongs in the same class with the man who refuses to believe that the world is round simply because he can't get off somewhere at a distance and see its roundness for himself.

The merchant who fears to attempt advertising because he figures it as an "expense" is blind to his own interests. I personally know several men who, because they once tried advertising to the extent of a cheaply printed hand-bill and didn't find it necessary next morning to call on the police to keep the crowds of eager buyers from swamping their store, loudly and solemnly aver that "advertising doesn't pay."

Advertising *does* pay.

The most successful merchants are the merchants who believe most thoroughly in advertising, and who practice their belief.

But advertising, in order to pay, has got to be *intelligent* advertising.

The day of hashed-over superlatives — "best goods," "lowest prices," "best stock in town," "greatest bargains ever heard of," and so on—has passed.

People have learned to distinguish the *truthful* advertiser from the blatant behind-the-times storekeeper who believes that, so long as *he* claims to have the best goods on earth, or under the earth, or within wireless distance of the earth, people will break their necks trying to get to his counters in the forefront of the crowd.

Put some *brains* into your advertising.

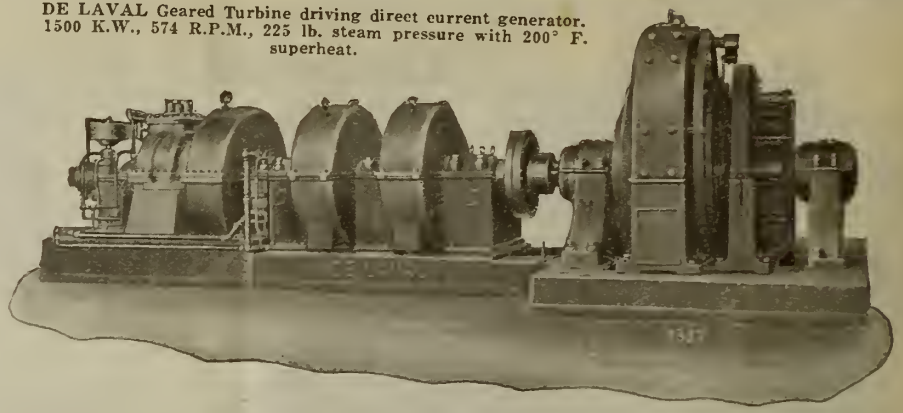
Don't let the office boy write your announcements in between his other duties.

Don't doubt the business-getting and business-building power of intelligent and informative publicity — and you will find that advertising *does* pay.

—*Jerome P. Fleishman.*

Steam Turbines *for* Driving Pumps, Generators, Shafting, etc.

DE LAVAL Geared Turbine driving direct current generator. 1500 K.W., 574 R.P.M., 225 lb. steam pressure with 200° F. superheat.



With alternating current distribution, speed variation for individual machines is difficult, but with direct current, each machine can be speeded according to requirements, thereby increasing the output to the maximum. For the operation of elevators, etc., direct current is indispensable.

A direct current generator geared to a De Laval steam turbine forms a simple, reliable and efficient unit.

If alternating current is required, as for transmission to a distance, there are many advantages in using a standard low speed alternator, as it is more simple and more reliable than a high speed alternator and can be taken care of and repaired by ordinary operating men. By the use of the De Laval double-helical speed-reducing gear, the turbine can run at the most efficient speed.

The De Laval double-helical speed-reducing gear makes the turbines available for driving slow-speed machinery as pumps and fans, also for rope and belt drives. The turbine is simple, easily cared for, requires few supplies and little attendance, and may be installed in limited space without expensive foundations. It maintains a good steam economy indefinitely.

Heavy overloads are carried at reduced steam pressure without distress or harm, merely by opening more nozzles.

Where there is exhaust steam available from other units more power can be obtained with no extra cost for steam by the use of the De Laval low pressure or mixed flow turbine. Where steam is wanted at low pressure for heating or drying, it can be taken from the exhaust of a De Laval back pressure or bleeder turbine.

Ask for catalog D100.

De Laval Steam Turbine Company

TURBINE EQUIPMENT CO., LIMITED,
73 King Street West, Toronto

THE E. LAURIE COMPANY,
243 Bleury Street, Montreal

TAYLOR ENGINEERING CO., LTD.,
Vancouver

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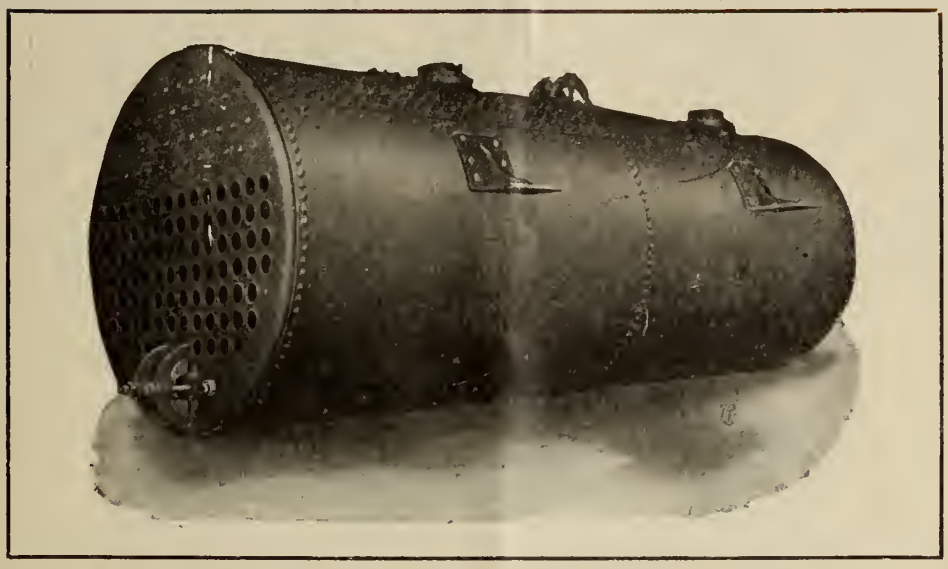
WE — FU — GO AND SCAIFE

WATER

PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



INGLIS BOILERS

TANKS AND ENGINES

Inglis Boilers, Tanks and Engines have been accepted as the Standard in Workmanship and Service in Canada for over half-a-century. Always reliable!

Write us for prices and specifications.

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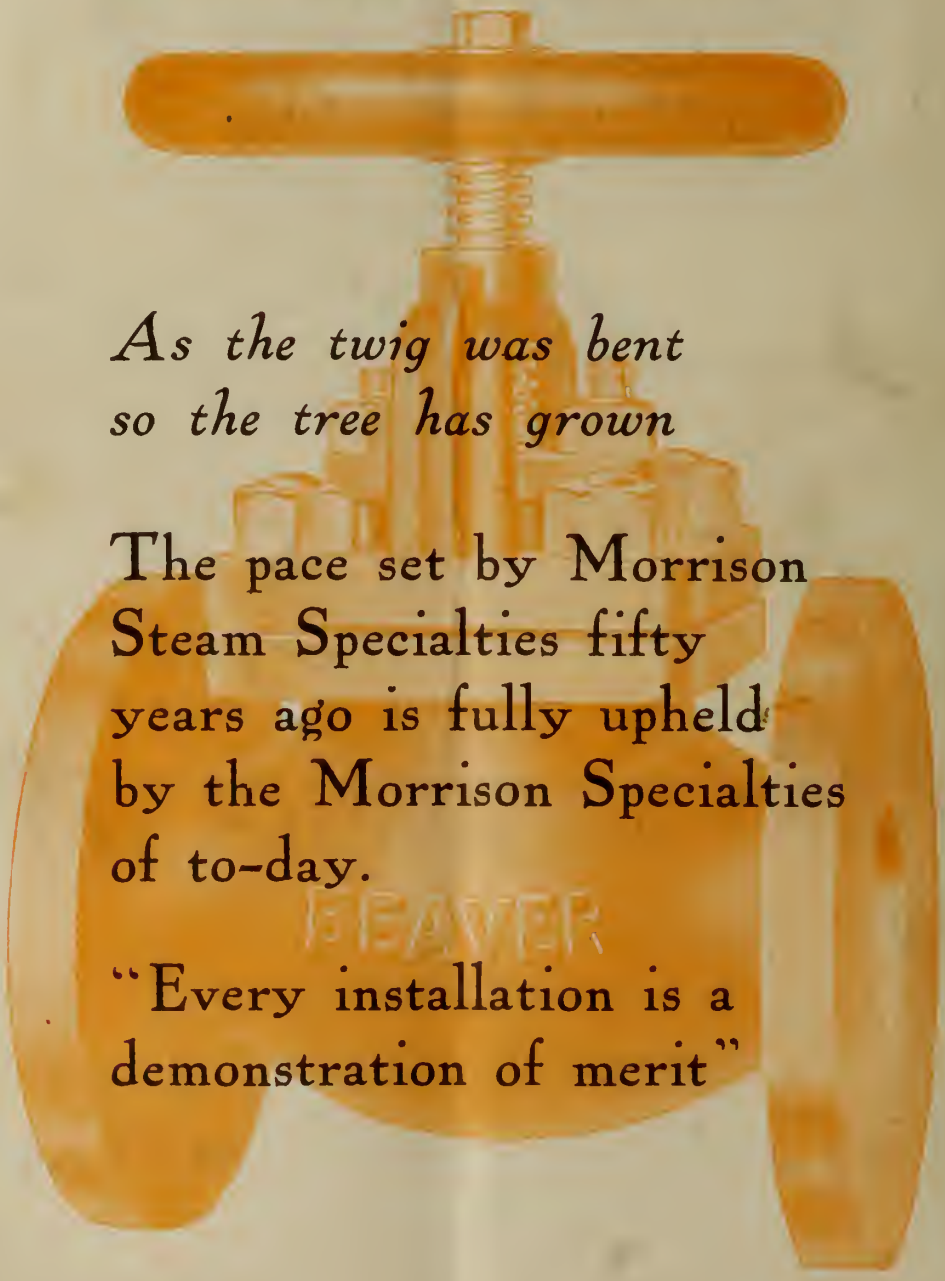
MORRISON

Steam Specialties



As the twig was bent
so the tree has grown

The pace set by Morrison Steam Specialties fifty years ago is fully upheld by the Morrison Specialties of to-day.

"Every installation is a demonstration of merit"

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide Street W., Toronto

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 901 Confederation Life Building

Vol. XIV.—No. 12. Publication Office, Toronto—June 20, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

"It's A Jenkins—
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Supply men everywhere sell Jenkins Valves with confidence based upon actual knowledge of the trouble-free service which these valves furnish.

Jenkins Diamond-marked valves are made in types and sizes to meet all requirements of service in power plants and wherever else a dependable trouble-free valve is required.

The dominant idea behind the construction of every Jenkins Valve is STRENGTH and proportions for MAXIMUM SERVICE —not merely the average. Every valve is tested in this regard before it leaves the factory.

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VALVES, of Bronze, Iron or Steel for lines carrying Steam, Liquids or Gases. Globe, Angle and Cross; Gate, Check, Throttle, Safety Non-return Stop, Pop Safety, Relief, Blow-off, Etc.

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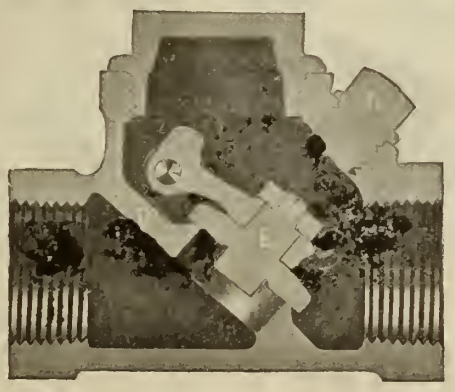


CUT NO. 544-A.

SWING CHECK VALVE

Get Away From Check Valve Troubles

by installing

The Penberthy Double Plug Check Valve

on Your Steam Lines

Cut No. 544A shows sectional side view and illustrates to advantage the liberal thickness of metal in diaphragm. (See letter D), also the even distribution of metal throughout. The disc (letter E) is also of liberal thickness, and as same is made of a special wear resistant bronze composition the Penberthy Check is practically indestructible, and will give many years of efficient service. All genuine Penberthy Checks bear our trade mark and the registered pressure 200 lbs., is also cast on each.

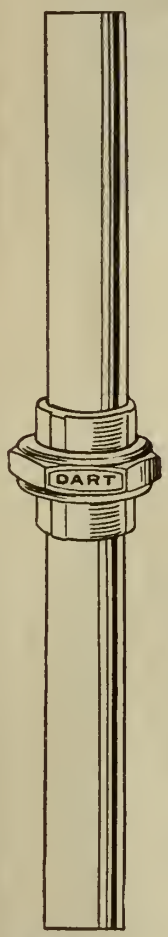
The double plug construction makes it possible to take the valve apart if mounted on a wall pipe without disconnecting same from the pipe. The plugs also act as bearings for the disc carrier pin and in case of wear it is only necessary to renew either plugs or pin, making valve as good as new. The top plug "A" is also removable for insertion of screw driver when regrinding disc and seat is necessary.

Stocked by leading jobbers everywhere.

Manufactured by

PENBERTHY INJECTOR CO. LIMITED
WINDSOR CANADA

A Joint That Will Not Leak Because— It Can't.



It Isn't Made That Way It *Is* Made Of Heavy Malleable Castings That Will Not Stretch

BRONZE TO BRONZE AT THE SEATS

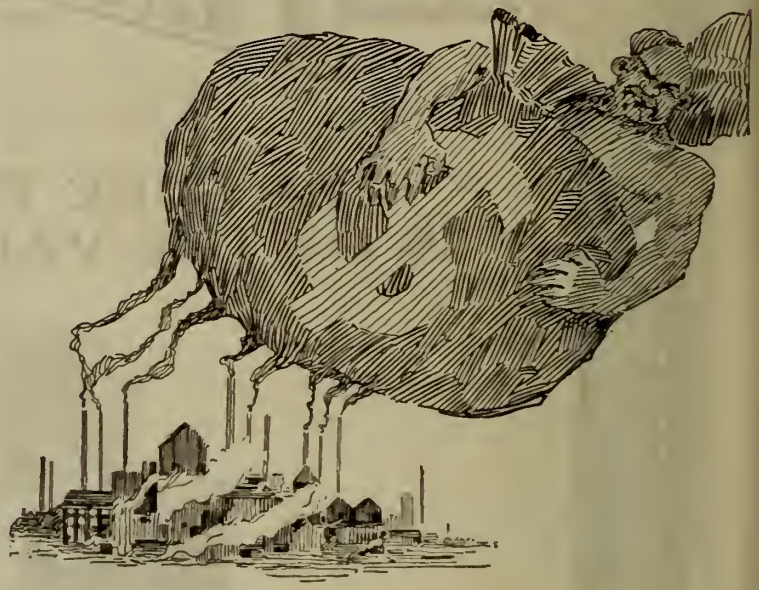
A job well done is satisfaction for ever. Use Dart Unions and you can rest assured that that part of the pipe line will never cause trouble. Furthermore, if a pipe line is not in alignment, it can be joined with a "Dart" because of the ball joint and ground seats.

MANUFACTURED BY

Dart Union Co. Limited

TORONTO - ONTARIO

What is YOUR Contribution?



All smoke clouds are made of money, but not all heat wasted up the chimney can be seen in the smoke. It is excess air escaping into the combustion chamber that carries the heat units up the chimney, cools the gases of combustion, and causes smoke. But

PLIBRICO JOINTLESS FURNACE LINING

stops that waste. Its air-tight, gas-tight construction prevents air infiltration, short-circuiting of gases, and heat radiation. Use PLIBRICO and pay only for the coal you use. Then no cloud of unburned carbon will float away from your stacks.

PLIBRICO is used in every case where laid-up fire brick is used, and with better results. Try it on a front-door arch or wall, or on baffle walls, and the saving effected will demonstrate the greater value of a complete PLIBRICO setting.

We guarantee a saving of time, money and fuel for those who install PLIBRICO.

Shipped in steel containers of distinctive appearance as shown below. Warehouse stocks in all principal cities.

Send for our booklet L 8 on Furnace Building.

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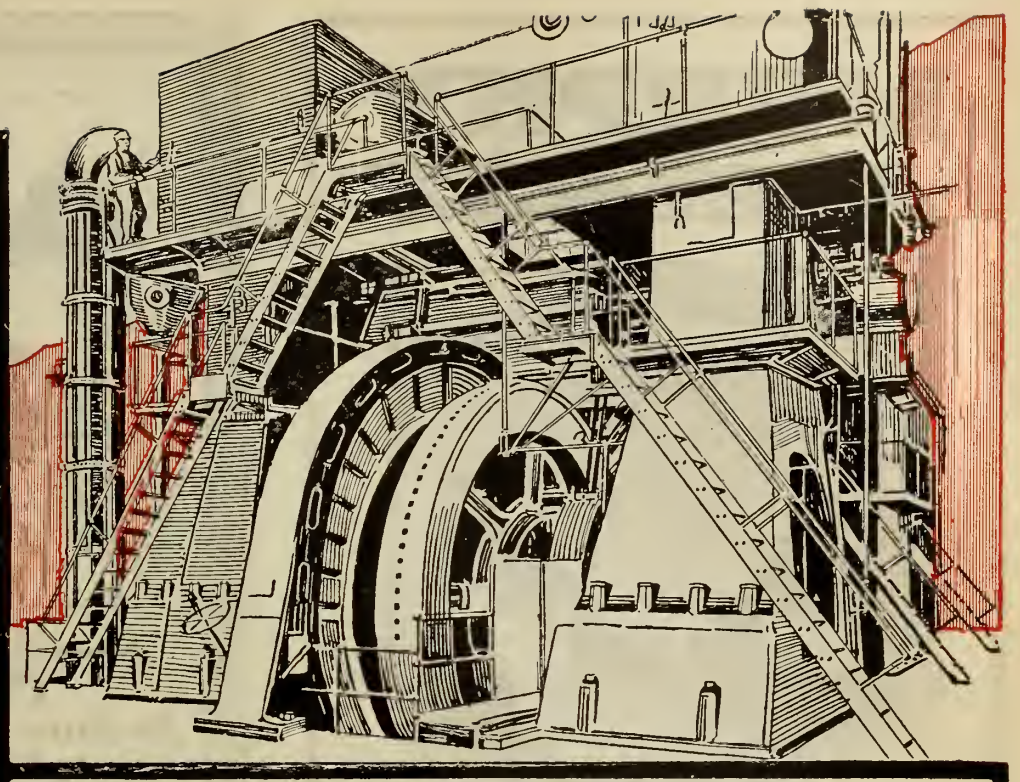

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PLANT operators insist upon efficient, scientific lubrication these days. They realize that poor oil is expensive at *any* price.

Imperial Lubricants are especially prepared to meet the modern demand for correct lubrication. There's a grade of uniform-quality oil for each different lubrication requirement of your plant. Supplies are always conveniently available.

Hundreds of firms all over Canada use Imperial Lubricants exclusively. Actual records show a marked reduction in overhead expense and increased capacity throughout plants where Imperial Lubricants are regularly used.

You cannot afford to buy any but the best oils for expensive machinery. Check over the accompanying list of Imperial Lubricants. See how fully it meets every lubricating need.

Imperial Engineers will gladly help you standardize the lubrication of your plant. Write to 56 Church St., Toronto.

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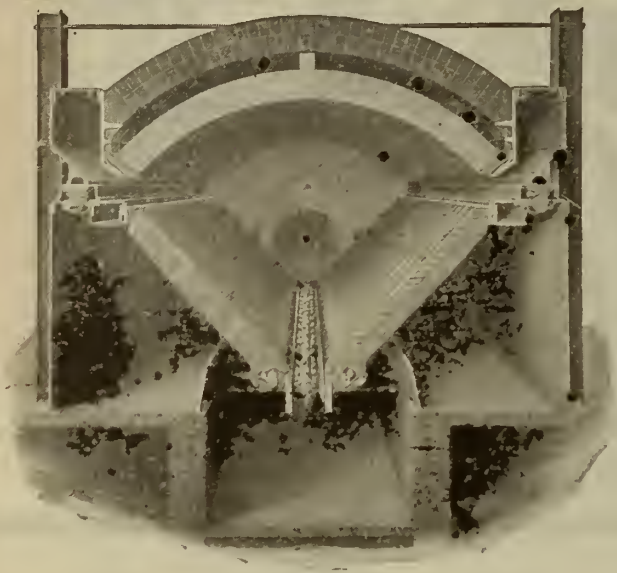
Power-Heat-Light-Lubrication

Five Canadian Refineries Branches In All Cities

MURPHY
AUTOMATIC
FURNACES



FACTORS BACK OF EVERY INSTALLATION OF MURPHY FURNACES

Natural Draft—On everything except the most extreme peak loads. Will double the output of your boilers without one penny for draft.

Burns Wide Range of Fuels—This is the biggest possible feature for the engineer to consider at the present time.

Standard—The Murphy Furnace is standard in design. All new features produced from time to time may be applied to any Murphy Furnace now in use.

Smokelessness—The Murphy Furnace is designed to afford perfect combustion. The arch insures high furnace temperature, which means that the air is preheated and admitted exactly where and when needed to give maximum efficiency.

Automatic Operation—The amount of fuel supplied may be regulated while in operation. Every detail for keeping a perfect fire is provided in the design and construction of the Murphy Furnace. The coal is supplied—the fire distributed evenly—the ash removed—continuously and automatically.

Our Catalogue HM-6 shows how Murphy Furnaces can be installed under any type of boiler—50 H.P. and up. Ask for it.

For information on RILEY UNDERFEED STOKERS for large boilers, see last month's advertisement or send for RILEY STOKER Catalogue "HR-6"

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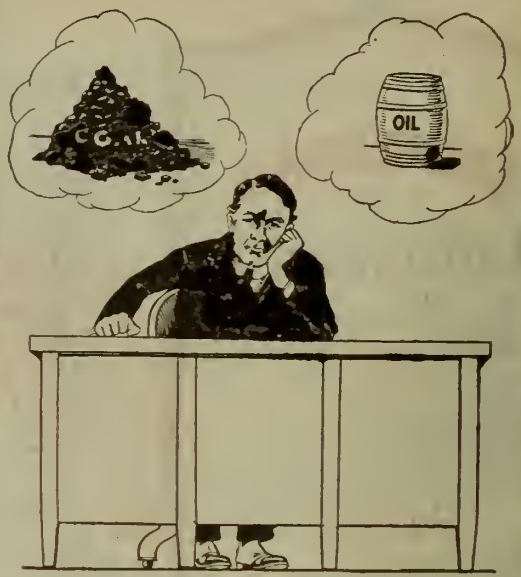
DETROIT MICH. U. S. A.

BUILDER'S VENTURI IRON FOUNDRY



Coal or Oil
Be Sure Which is the Best Fuel for You

Availability of fuel, economy of space, cost and amount of labor, etc.—all enter into the consideration of the advantages or disadvantages of fuel oil as compared with coal in your power plant. However, the factor which invariably figures most prominently in the final decision is **Evaporation Per Dollar Spent For Fuel.**

THE VENTURI
BOILER FEED METER

is practically indispensable in determining **Evaporation**, because it is the most practical, the most economical, and the most efficient means of knowing the rate and method of feeding water to the boilers at all times.

The Function of the **Venturi** remains equally important after oil burning equipment has been installed, because **Evaporation** is still the big problem.

Bulletin 197 is ready. It is yours on request.

Type M Register Indicator Recorder

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"Builders of the Venturi"
PROVIDENCE, RHODE ISLAND
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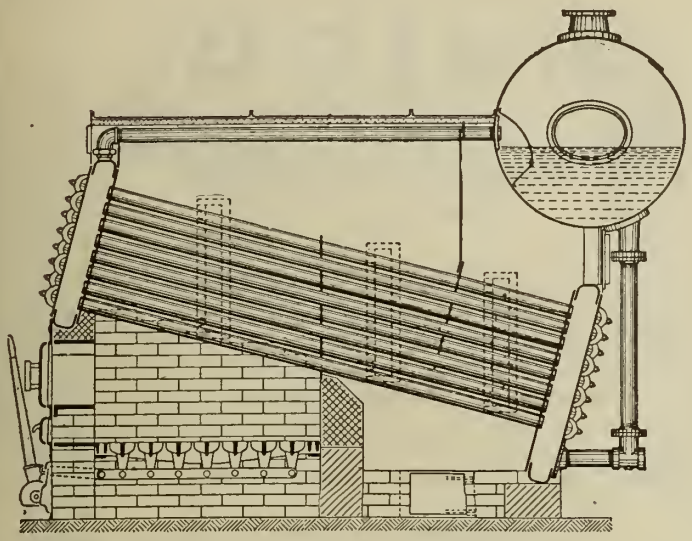
The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N. S.

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High Stack Temperature	**It's Your Money --- Take Your Choice**	Low Stack Temperature
Minimum Steam Production		Maximum Steam Production
Fuel Waste		Fuel Saving
Excessive Labor Cost		Reduced Labor Cost
40% Average Soot Removal by Hand Blowing		95% Average Soot Removal by Vulcan Soot Cleaners

This is the story of Vulcan Soot Cleaners—in a nutshell.
If your plant isn't Vulcan-equipped, your up against the drawbacks listed at the left.
When your boilers are Vulcan-equipped, you're assured of the advantages listed at the right.
Whatever may be the generally good operating conditions of your boilers, it is impossible to maintain maximum results by hand blowing.
It is only through the installation of mechanical soot cleaners—Vulcans—that steam production can be maintained and fuel saved at the same time.
The lack of Vulcan Soot Cleaners in your boilers spells W-A-S-T-E!

Can you afford it?

Let us tell you all about Vulcans and what they can accomplish for you. Please mention type of boiler, steam pressure, and number of tubes high and wide.
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The VULCAN SOOT CLEANER COMPANY

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Green's Economiser Ltd., Kent Building

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

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With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

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Hamilton, Canada

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The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

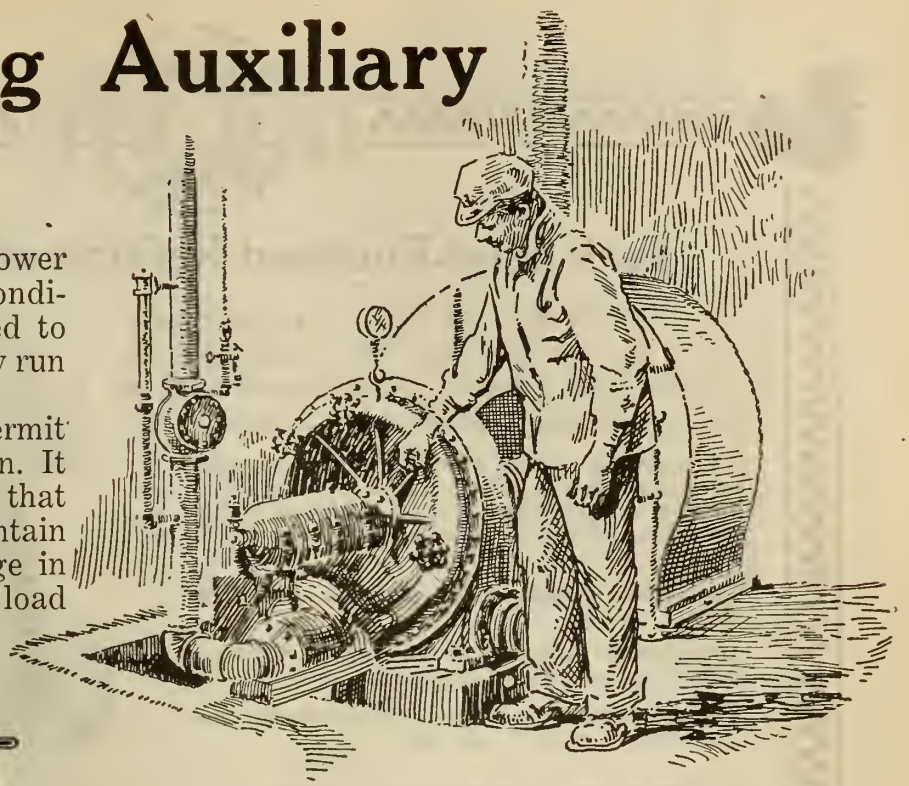
A trial order will convince you of their utility.

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal

Steam Saving Auxiliary Drives

The auxiliaries in the modern power plant seldom operate under ideal conditions. Most of them are subjected to severe load fluctuations and usually run underloaded.

The high price of coal does not permit extravagance in steam consumption. It is therefore extremely important that the drives selected are able to maintain a good economy over a wide range in load. Operate at nearly full load economy at one-quarter and one-half load.



Sturtevant Steam Turbines are used to drive exciters, boiler feed pumps, house pumps, fire pumps, fans, blowers and special equipment. They combine safety and dependability with high economy under all conditions

Sturtevant (TRADE MARK)

Steam Turbines

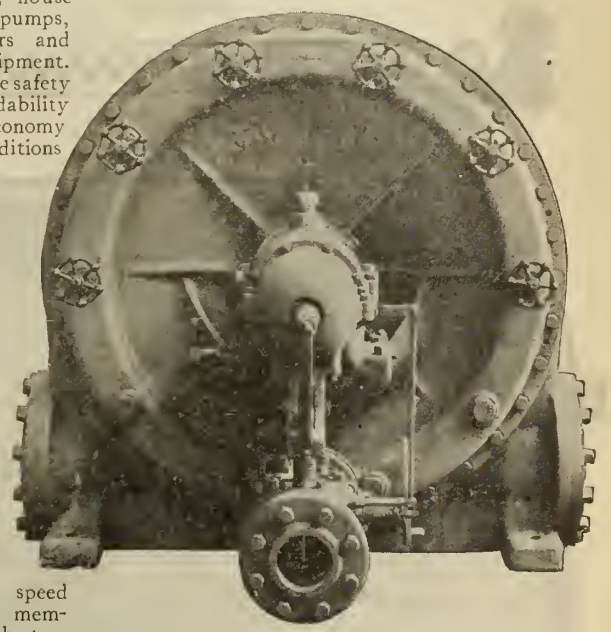
They are not controlled by throttling down the steam, but by shutting off one or more of the several steam nozzles by the hand wheels on the turbine casing. The nozzles remaining in service undergo no change in efficiency.

The turbines are scientifically designed and all parts are constructed accurately to gauge of the best obtainable materials.

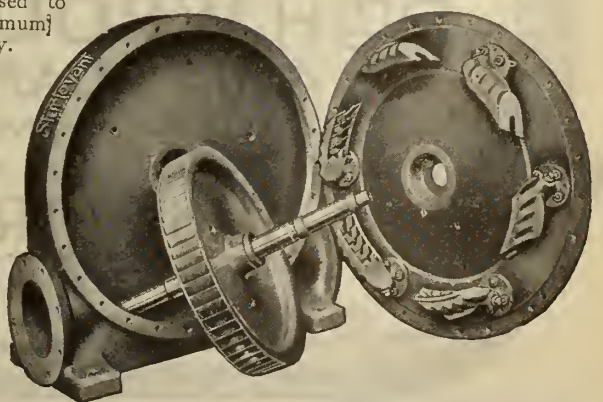
The assembly is made under expert supervision and a true running balance is established.

A positively dependable shaft governor holds the speed regulation within close limits and entirely adapts these turbines to drive electric generators.

Consultation with our engineers is recommended before selecting any turbine drive.



When the speed of the driven member is below the turbine speed Sturtevant Transmission Gears are used to obtain maximum efficiency.



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B. F. Sturtevant Company of Canada, Ltd.

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QUALITY YORK SERVICE

York Semi-Enclosed Refrigerating Machines

The Raw Water Ice Plant is rapidly taking the lead, and its development demands an Ammonia Compressor that is most economical in Power Consumption.

Where electric current is available at a reasonable cost, our Semi-Enclosed Machine, with direct motor mounting, makes a neat, clean and highly economical plant—no belts, no engine or steam lines.

The machine occupies a comparatively small floor space.

All the power developed by the motor is delivered to the crank-shaft of the machine.

These machines are built in sizes from 30 tons refrigerating capacity upwards.

Prices and complete information on application

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(Ice Making and Refrigerating Machinery Exclusively)
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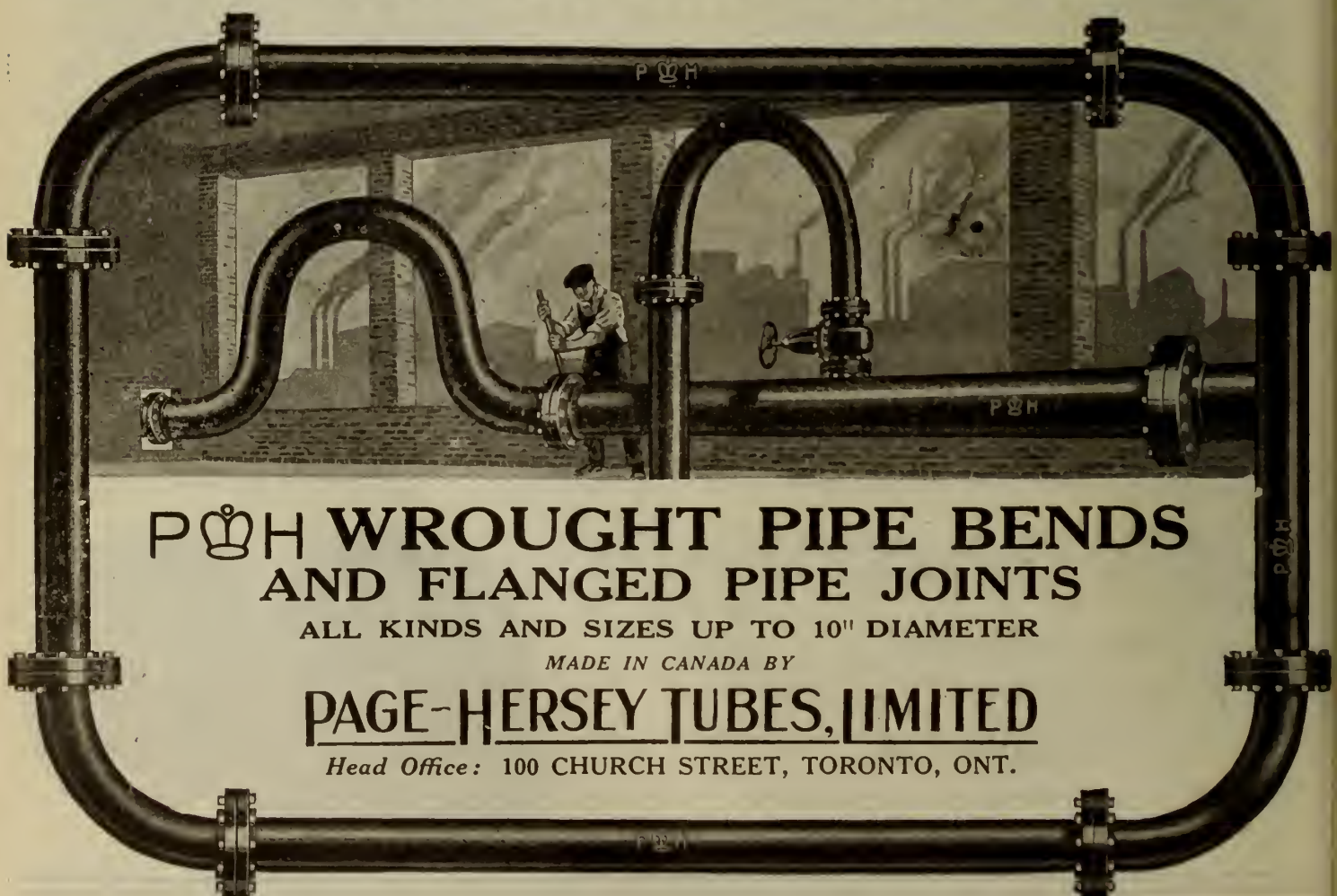
MONTREAL: 324 Craig St. West WINNIPEG: 85 Lombard St.
CALGARY: 605 Second St.



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AND FLANGED PIPE JOINTS
ALL KINDS AND SIZES UP TO 10" DIAMETER
MADE IN CANADA BY
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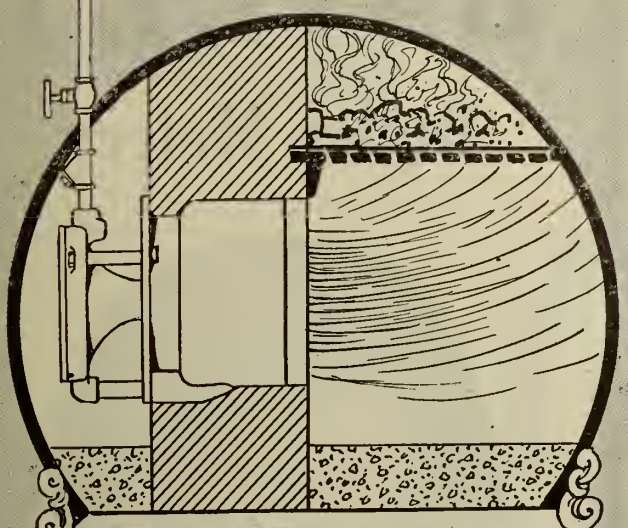
Head Office: 100 CHURCH STREET, TORONTO, ONT.

Burn any Fuel



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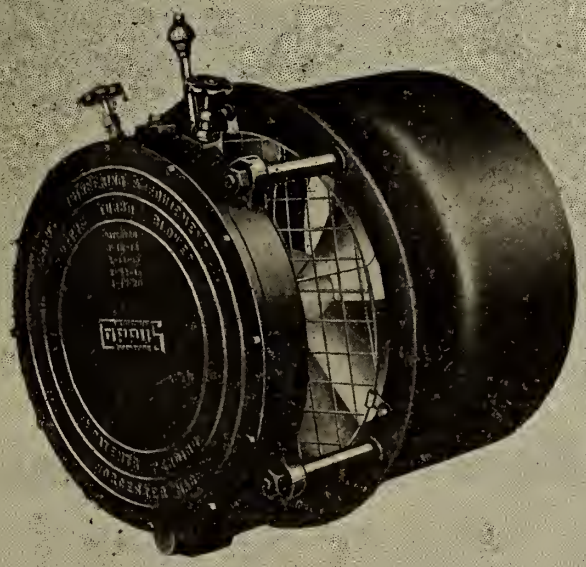
TURBO BLOWER MAKES BETTER COMBUSTION POSSIBLE



Coppus Turbo Blowers make you independent of fuel conditions —you can burn yard screenings, buckwheat coal, coke breeze, culm, slack bagasse, or refuse such as sawdust, shavings, tan-bark, etc., because it provides sufficient draft for complete combustion with any grade of fuel.

A Coppus Turbo Blower forcing air into the ash pit, provides a strong draft through the fuel bed. A turn of the valve shoots steam connected to and turns the fan. to the turbine which is directly Regardless of fuel quality you are provided with the means to make it burn as intensely or as low as you wish.

The Coppus Blower is easily and quickly installed and requires no attention other than lubrication once or twice a year.

There are many other rea ons for Coppus Blower superiority, and they are completely told in our catalogue which will be sent to. you on request.

Coppus Turbo Boiler Feed Pump

This turbine driven boiler feed pump—built as a single unit—supplies a continuous flow of water without pulsation or vibration. No valves to be reground, no water plungers or steam pistons to be repacked, no complicated governing devices to be adjusted.

The Coppus Centrifugal Turbo Boiler Feed Pump responds immediately to peak loads and requires little or no attention due to the automatic and dependable lubricating system—that's why so many power plants have installed them in place of more cumbersome and complicated pumping outfits.

We shall be glad to send you the Coppus Turbo Boiler Feed Pump Bulletin also.

The Coppus Engineering & Equipment Co.

341 Park Ave., WORCESTER, Mass.

Agents for Montreal
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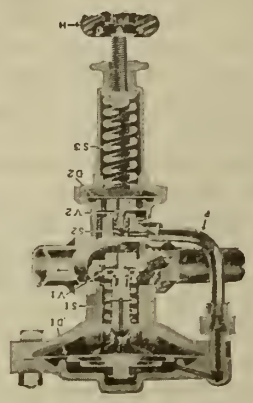


LOW PRESSURE CAN'T BUILD UP

If you manufacture a product requiring curing, drying, bleaching, dyeing, vulcanizing, evaporating, or any other process dependent upon a uniform temperature or pressure you will certainly be interested in

FISHER PRESSURE REGULATOR
Series 90

It will accurately and consistently deliver any desired reduced pressure to apparatus.

It will also shut off absolutely tight when low pressure is interrupted. Pressure cannot build up on the low pressure side.
Like all other Fisher specialties this valve is distinguished by excellence of material and workmanship.

Actual service in thousands of plants throughout Canada has proven Fisher Power Plant Specialties to be long-lasting and accurate in the most trying and delicate operations.

Ask your dealer or jobber for full information about the Fisher line. Or write for "POWER PLANT SPECIALTIES." It is full of interesting information. We will gladly send you a copy. Write today.

The Fisher Governor Company
922 Fisher Avenue Marshalltown, Iowa.

BAILEY

Boiler Meters

Keeping Account of Your Steam Cost

Bailey Boiler Meters not only show the true output of each boiler, but also enable you to keep a continuous check on the furnace efficiency.

The charts record the Steam Flow in red, the Air Flow in blue, and the Flue Gas Temperature in green.

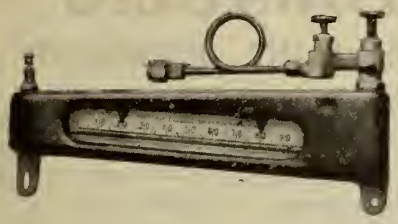
Where stokers are installed pens for recording Wind Box Pressure, and Stoker Speed may be added. Also an indicator for Furnace Draft is provided. In either type an integrator shows the total amount of steam generated by the boiler.

Bulletins upon request.

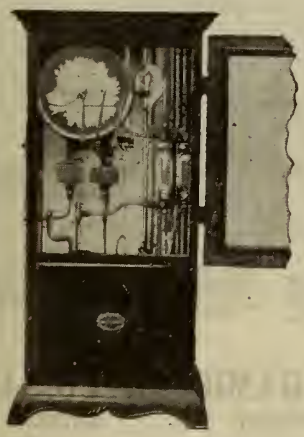
Bailey Meter Company

2001 E. 46th St., Cleveland, O., U.S.A.

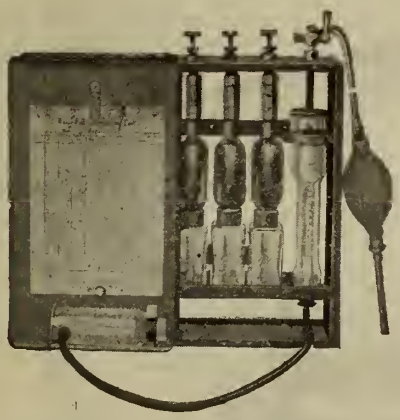
COAL SAVERS



Hays Draft Gage for the boiler front to guide the fireman in regulating draft.



Hays Automatic Co_2 and draft Recorder Awarded Certificate of Merit by the Franklin Institute.



Hays Improved Gas Analyzer for CO_2 O_2 and CO.

Hays apparatus sold in Canada by

Edward A. Robinson, Montreal.

Wm. A. Goold, Winnipeg, Man.

Arthur S. Leitch Co. 1001-2 Kent Bldg., Toronto.

Hays Apparatus

has a national reputation for solving combustion problems. Like Joseph W. Hays himself, Hays Instruments are pioneers—leaders in the promotion of combustion efficiency.

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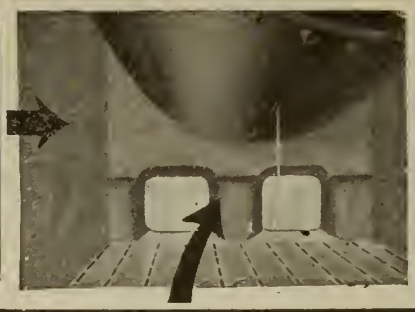

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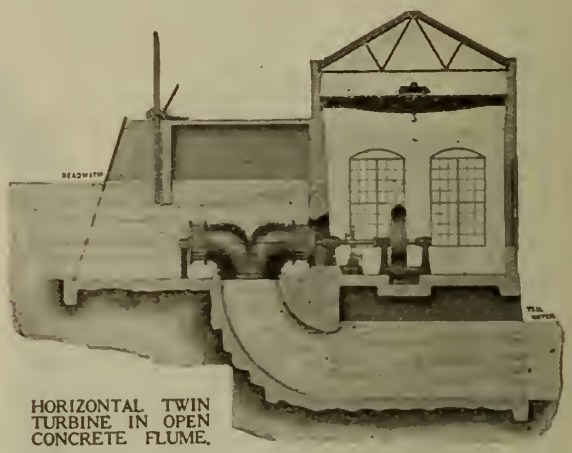

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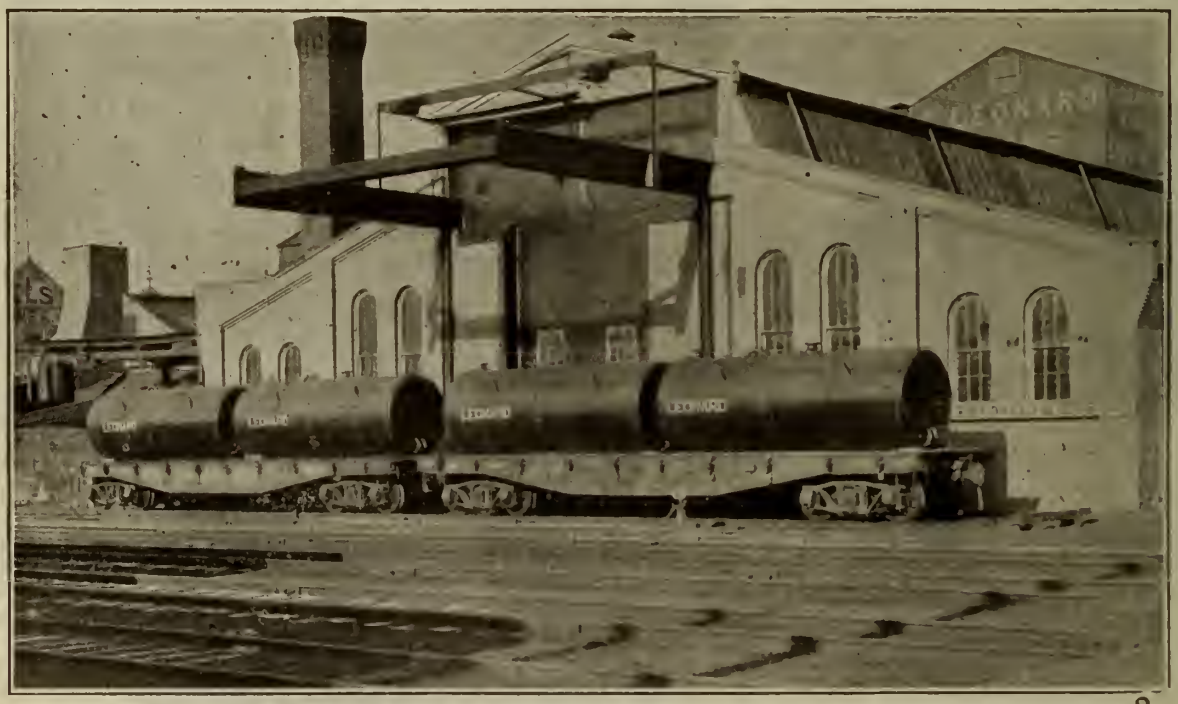

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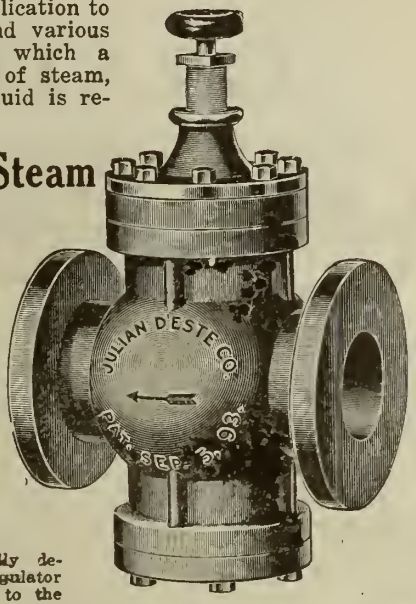

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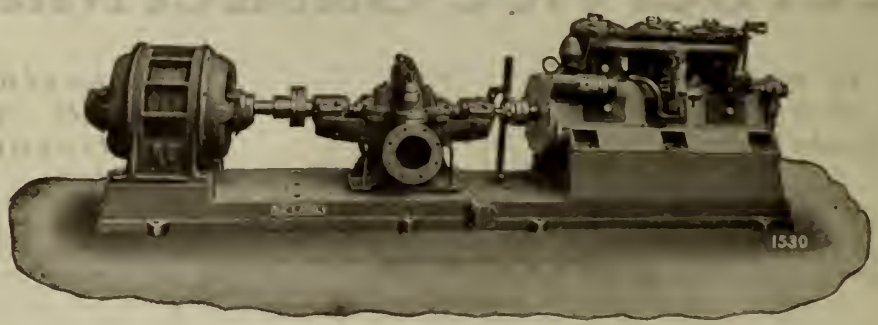

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THE eight-inch De Laval centrifugal pump shown herewith is arranged to be driven either by an induction motor, or, when electrical power is not available, by a 6-cylinder 100 horsepower gasoline engine. A clutch is provided for disconnecting the engine when not in use. The unit is rated at 2,100 gal. per min. at 1,160 r.p.m. With a duplicate power supply there is practically complete assurance of being able to deliver water at all times. The characteristics of De Laval centrifugal pumps are ideal for such service, as there is practically zero starting torque and, due to the power-limiting characteristic, the De Laval pump cannot possibly overload the motor.

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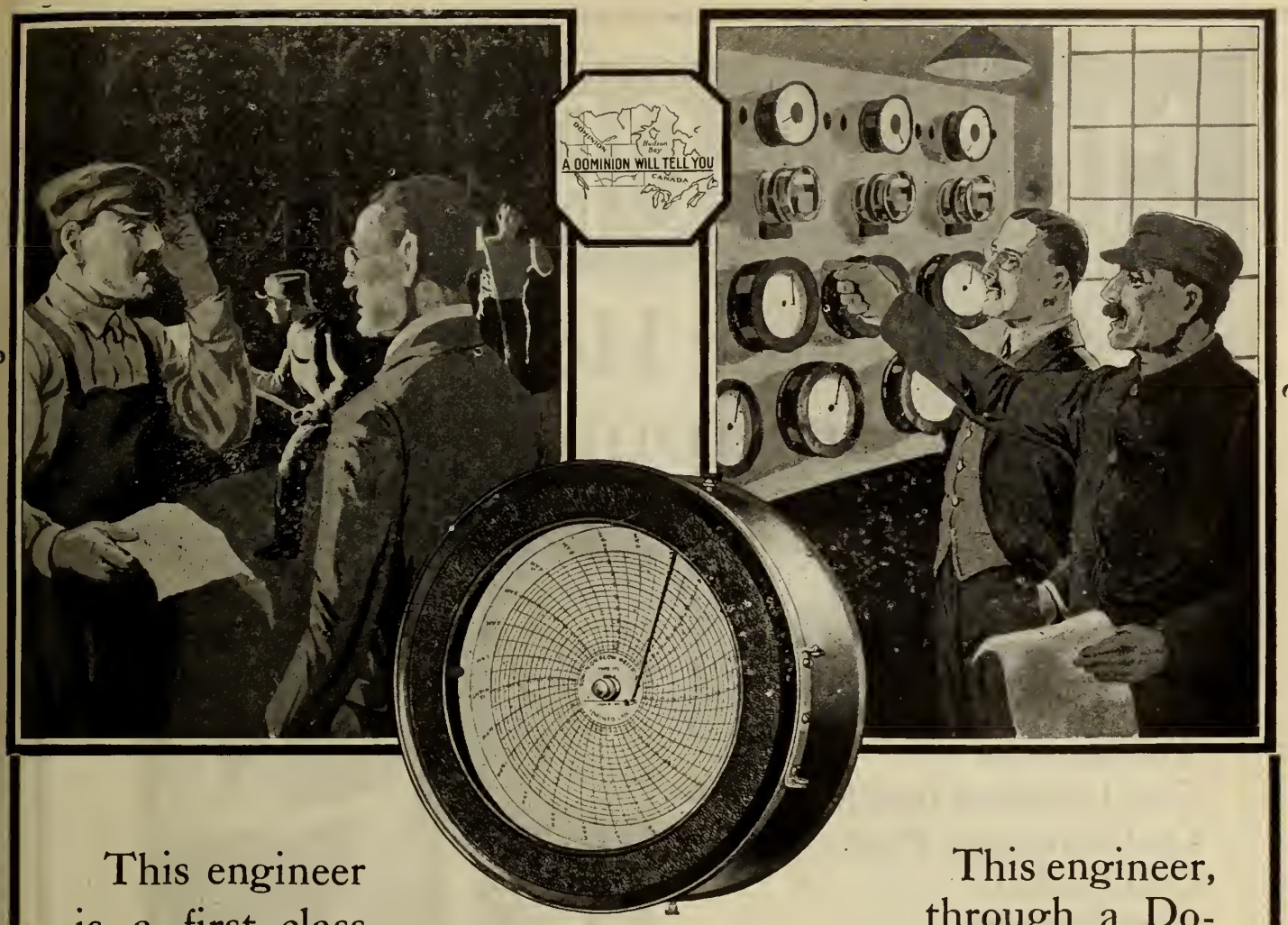

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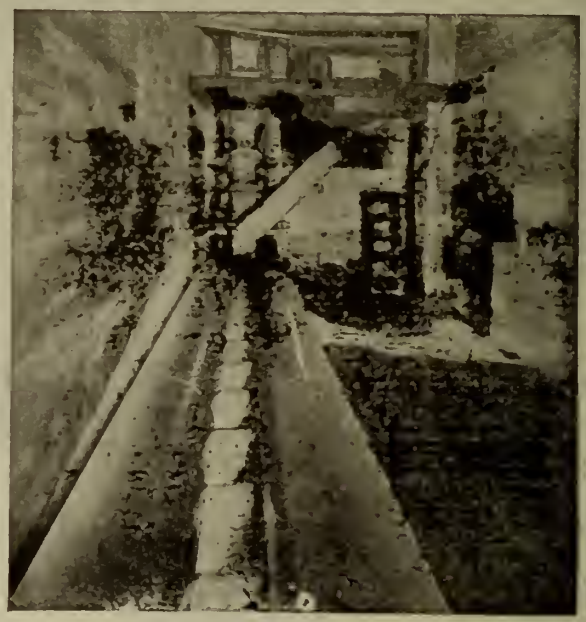

Mead-Morrison Bucket Conveyor and Belt Conveyor installation in Power House of Berliner Gramaphone Co., Montreal.

Cut shows guards over wheels, links, etc. to protect them from ashes being dumped into conveyor.

Capacity is 20 - 300 tons per hour according to size of buckets.

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By handling coal with a GODFREY CONVEYOR, a prominent company has written us of the above saving. Write us for their name and location.

They also have written us as follows: "We have on several occasions had three cars on the track in one day with an average of 42 tons to a car, and unloaded them in six hours with one man. We never give demurrage a thought any more, whereas we would formerly average one car in three."

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Release cars promptly
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In the operating records of Jones-equipped plants one fact stands out boldly:

Although the Jones "A-C" is the simplest of first class multiple-retort stokers, it meets the most rigid requirements of high-duty stoker firing supremely well.

It continuously sustains the heaviest overloads. It momentarily meets highest peak loads. And because of its rugged simplicity, it does this at lowest maintenance costs as a result of—

No Clinker Formations on Bridge or Side Walls

No Moving Parts in the Fire

Very Simple Operating Equipment

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No Complicated Power Dumping Mechanism

The maintenance cost of Jones "A-C" Stokers is unusually low because of extreme simplicity both in design and operation. Every part is accessible. There are very few moving parts—none in the fire. complicated power dumping mechanism is used. The fire is automatically kept clean, and accumulated ashes on the balanced dump plates are quickly and easily dumped y hand. The automatic fuel and air controls are subject to independent adjustment and the operation of each retort is under separate control. A perfect fuel bed can be maintained at all times, using any grade of Canadian coal. No clinkers are formed either on the bridge or side walls. This extreme simplicity and accessibility insure the lowest maintenance cost.

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Published in Toronto

Established 1907
Published Semi-Monthly

The Power Plant of the Acadia Sugar Refinery

This plant, one of the largest in the Maritime Provinces, has lately made a change in the fuelling arrangements. Oil fuel will be the principal means of steam generation in future.

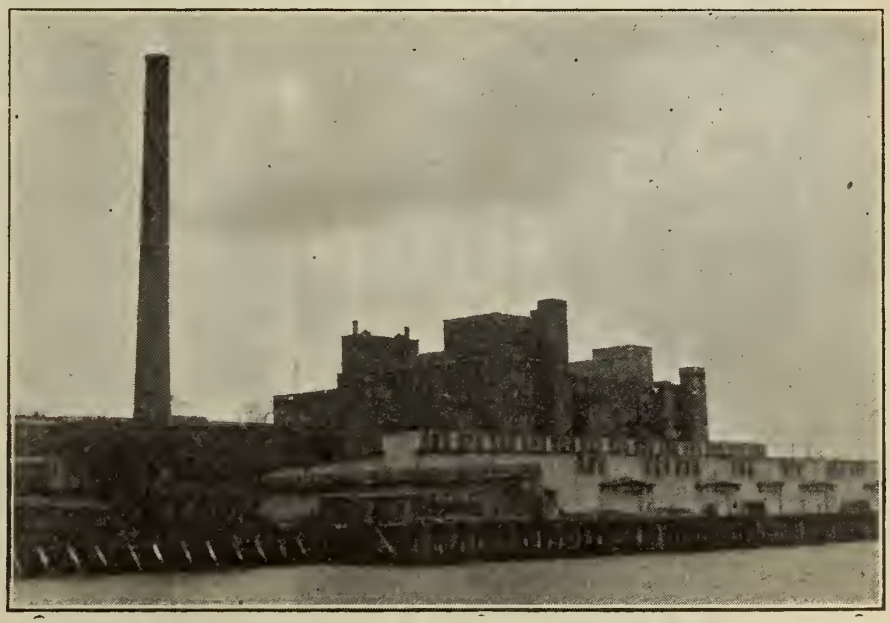
By J. A. McGILLIVRAY

LOOKING back some fourteen years to the time that the Acadia Sugar Refinery was erected, considerable development in power plant engineering practice is noticeable. During that time more attention has been paid to the science of combustion and economical generation of steam than in any other period since steam engineering came into being. It is interesting then to note that in 1907, when this plant was built, it was considered to be an outstanding example of up-to-date designs and was, in fact, one of the first plants in Eastern Canada to adopt the chain grate stoker. The plant, as then built, stood until 1912, when a fire occurred of such serious proportions that the whole plant had to be rebuilt, and it was 1914 before the plant was again in operation.

The new buildings were constructed of steel and concrete and brick, and when completed had a water frontage of 2000 feet on Halifax harbor. The refinery and power plant occupy a conspicuous position on the Dartmouth side of the harbor, and the tall chimney of the power plant rising 285 feet above the waters of the harbor, is an outstanding feature of the landscape.

The Power Plant.

The plant consists of a battery of ten Babcock & Wilcox boilers of 324 rated horse power, one of 430 horse power, and one of 640 horse power. The ten 324 h.p. boilers are equipped with superheaters, while the two latter boilers are used for supplementing the low pressure steam lines, and are not furnished with superheaters. Steam is used for both superheaters. Steam is used for both power and manufacturing purposes, the prime movers being turbines direct connected to generators. A very complete installation of coal handling apparatus has been installed, but owing to the fact that the plant is being changed over very largely to oil fuel burning, this will be very little used in the future. For the same reason the ash conveying plant is of little use at present, and a skip hoist is used, as will be explained in the course of the article. The coal burning boilers are being used only for emergency purposes, the daily load being carried on the oil fired units. The manufacturing requirements call for all the exhaust steam from the turbines, and also from the two boilers already referred to. All the returns are collected and delivered to the feed water heater, and the water from this is passed through an economiser and raised through a considerable range of temperature before delivery to the boilers. The above gives a general idea of the layout of the plant, and we can now introduce the reader to the details which go to make up the complete plant and ensure its efficient operation.

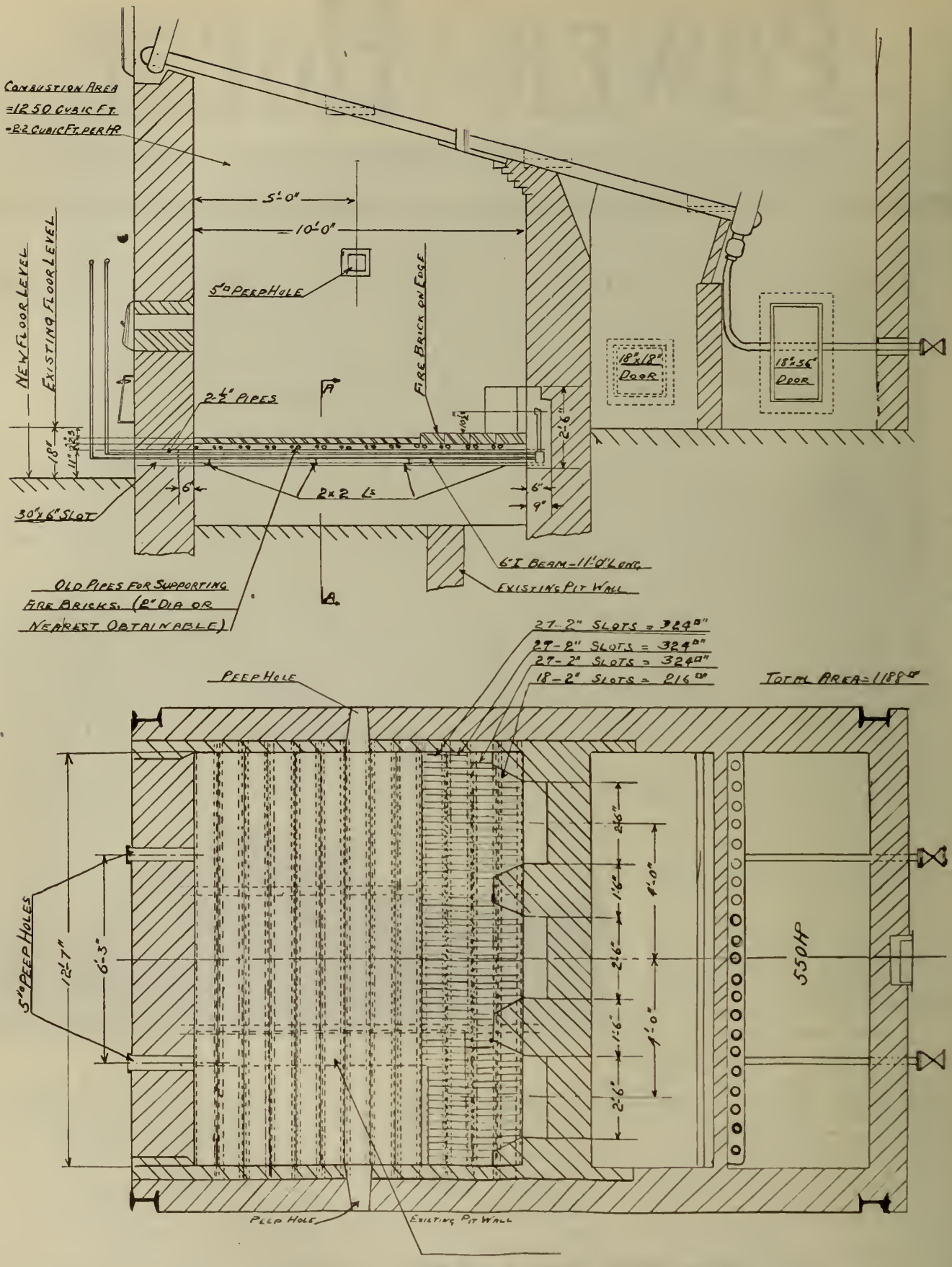


ACADIA SUGAR REFINERY

The Coal Handling Plant.

The coal handling plant is an interesting installation, having been designed with a view to complete control of the coal from the railroad cars or from barges, to the boilers, bunkers, or ground storage.

The complete conveying system has a capacity of twenty tons per hour, and is driven by one motor of 40 H.P., which is conveniently situated on the ground level, in a clean and accessible position. This motor drives to the main gear by a chain drive, while the various conveyors can be thrown in and out of gear by friction clutches. The motor, which is of the slip ring type, can be operated from the conveyor tunnel. Coal can be delivered to the overhead bunker which has a capacity of 450 tons, or to the storage, and it can be reclaimed from storage as required and delivered to the bunker. The storage has a capacity of 5000 tons, and the overhead bunker can hold 450 tons. There is a coal crusher of the two-roll type, 20 x 24 in., to break the coal up in small enough size for the chain grate, while the two main belt conveyors are 30 ins. wide with a capacity of 20 tons per hour, the smaller belts being



PLAN AND ELEVATION OF NEW SETTING

18 in. wide. The illustration, figure 1, gives a very clear idea of the layout of this conveyor system. On account of the elimination of ashes, the conveyor is not shown. The present arrangement is to take the ashes from the ash tunnel by a skip hoist, and dumped into a concrete storage bunker, from where it is loaded into railroad cars, etc., for use in grading, ballasting, and kindred uses.

The Boiler Installation.

The boilers that were served by this coal handling equipment, and which are partially served by it at present, are all of the Babcock & Wilcox water tube

type. The main battery consists of ten boilers, each having a normal rating of 324 H.P., which is obtained by the use of 32,400 square feet of heating surface.

A pleasing feature of the installation is the absence of the usual noise attendant on oil burning systems. This is mostly due to the remoteness of the atomizers. The change from coal to oil was made without having to modify the old settings to any great extent, and as the ashpits were unnecessary with the oilburning equipment it was an easy matter to lower the settings and shove the rear wall back without having to disturb the baffles.

There is also a superheater on each boiler, containing 8100 square feet which is in the ratio of one quarter square foot of superheater surface to one square foot of heating surface. The steam is superheated 125 degrees at the superheater, and enters the turbine stop valve at about 100 degrees superheat, the boiler pressure being 160 lbs. gauge. On account of the large amount of steam required for boiling and other manufacturing purposes, it is necessary to have two boilers in addition to the ten just mentioned, without superheaters. These boilers supply the steam lines in the factory with low pressure steam, but they can be used to supply the turbines if necessary. The heating surface of these two boilers is 10,900 square feet. All these ratings are of course capable of being raised if necessary.

The boilers are fed with water from the company's own reservoir, which has a capacity of 7,000,000 gallons, and is supplied from a lake situated about two miles from the plant. The water is pumped into the reservoir by two motor driven automatically controlled centrifugal pumps with a capacity of 1,000,000 gallons each per day.

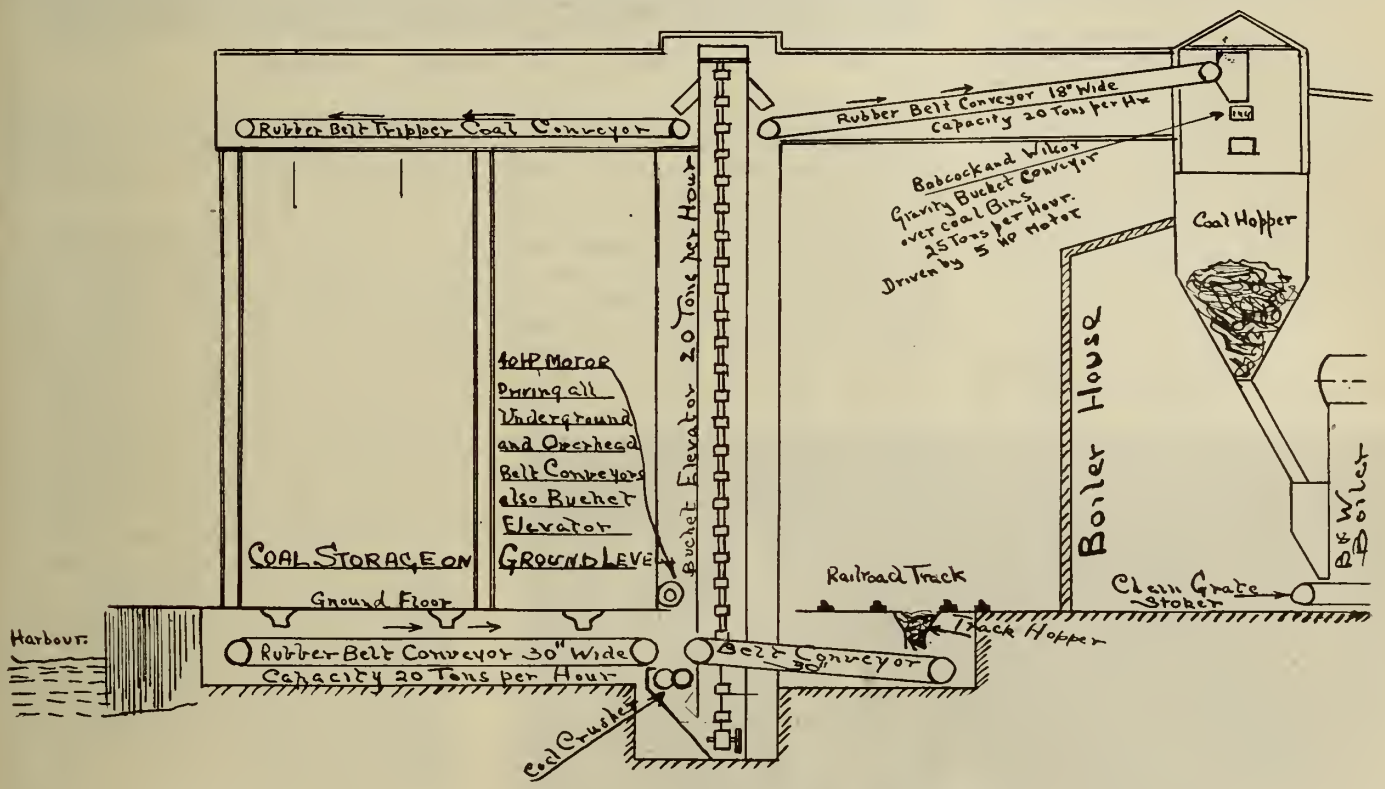
All the steam used in the building and in the turbines is returned to the receiver above the feed pumps. No feed heater is used, the temperature of the returns being in the neighborhood of 180 degrees and the pumps deliver the water to the boilers through an economiser containing 17,958 square feet of heating surface, which raises the temperature of the water entering the boiler to 245 degrees. This economiser reduces the temperature of the escaping gases to between 350 and 400 degrees. The feed water passes through a Venturi meter on its way to the boilers, so that a check can be kept on the quantity evaporated.

The feed pumps are of the centrifugal type, and consist of two Mather and Platts, motor driven, with a capacity of 250 Imp. gallons per minute at 414 feet head, and two Lee Courtneys turbine driven by Terry turbines of the same capacity. These pumps draw directly from the hot water receiver, which is placed about nine feet above the pump suction. Each boiler is equipped with a Crane non-return stop valve on the main steam pipe, leading to the header. The header itself is anchored in the centre and is free to expand towards either end. For manufacturing purposes steam is reduced through Locke regulators, and low pressure steam is also taken from the turbines by bleeders. For the purpose of obtaining accurate records of performance, steam flow meters and CO_2 recorders are being installed this year. The CO_2 outfit will probably consist of a recorder, with individual indicators on the oil burning boilers. Automatic feed water regulation is another feature to be installed during the present year. Natural draught is used exclusively, and for this purpose the stack is 255 feet above the level of the grates, with an effective area of 74½ square feet, making it capable of handling 4000 H.P. boilers. This is ample for the plant, which normally has about 3600 boiler horse power in service.

Oil Fuel.

The coal burning boilers are at present used as a standby—of these there are four.

The fuel oil is supplied by the Imperial Oil Company through a 4-inch underground line from their plant about 1¼ miles away. The oil is delivered to two receiving tanks shown in Fig. 4. These tanks are 35 ft. in diameter by 20 ft. high and have a capacity of 143,724 gallons of oil each. From the supply tanks situated at the rear of the plant and at an elevation of 40 ft. above the boiler room level the oil flows into two underground concrete supply tanks, with a capacity of 300 barrels of oil, or equivalent to about 100 tons of coal, bunker storage. The oil is pumped from the underground tanks through a steam heater at a pressure of 40 lbs. per sq. in. to the atomizers. The oil temperature is maintained at 190 deg. F. and the pressure is kept constant by a Locke regulator. The six 324 H.P. are equipped with two burners and the two larger boilers with three burners. The oil line to the burners is ½ in. diameter. The



SECTIONAL ELEVATION OF COAL CARRIERS

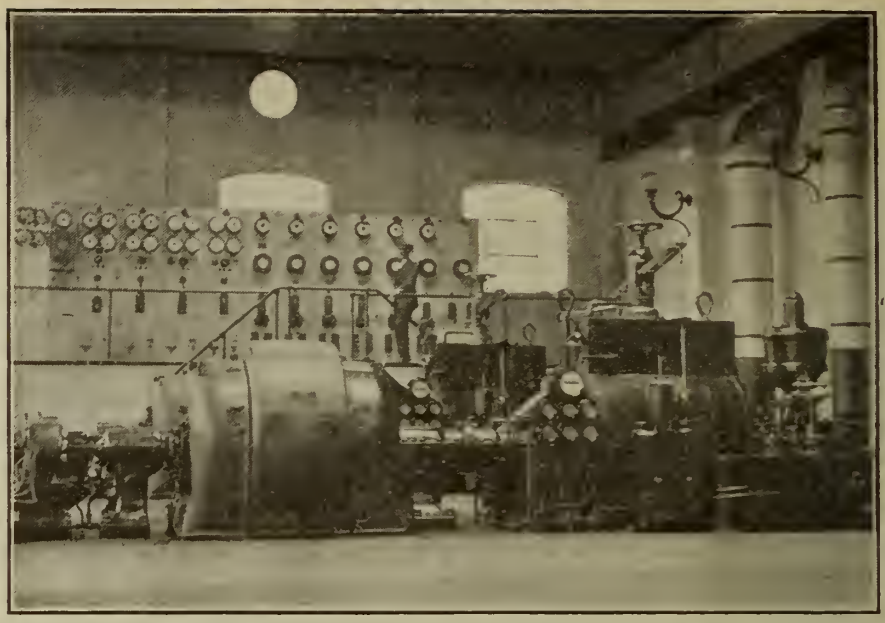
atomizers are of the Best and Leahey type, and are situated at the rear of the furnace.

In order to get the necessary furnace volume the settings were lowered 18 in. below the old floor line. This gave a furnace volume of 2.2 cu. ft. per H.P., and is in substantial agreement with good practice and makes for high combustion efficiency. As the burners are situated at the rear of the furnace the flame is projected forward and upward. This gives the gases of combustion an increasing volume away from the ignition point which feature has been proven to be highly desirable.

The distance from the centre line of the atomizer to the top of the checker work is 10½ inches.. The refractory material is laid on supports made from old 2½ in. pipe laid on beams. The checker work is laid for a distance of 3 feet toward the front of the setting and extends the full width of the furnace. The openings in the checker work are 2 x 6 in. and give an area of approximately 2.2 sq. in. per H.P. or approximately 1 sq. in. of opening per cu. ft. of furnace volume. With natural draft this works out very satisfactorily. The volume of air is controlled by dampers in the uptake. The oil to the atomizer is controlled by an operating valve at the front of the boilers.

Turbines.

The two main turbines are Westinghouse, non-condensing bleeder type—750 K.W. 3600 R.P.M. when exhausting at 23 lbs. abs. back pressure, into the low pressure heating line and bleeding 45,000 lbs. per hour from the first stage at 45 lbs. gauge pressure for manufacturing purposes. The steam pressure at the turbine throttle is 150 lbs. 100 deg. superheat (the writer recently saw the turbine in the foreground opened up for inspection and after being in operation for seven years the blading is still in good condition). The turbines are direct connected to Westinghouse 3-phase 600 V. 60 Cycle, 940 K.V.A. Generators, 3600 R.P.M. with direct connected 115-V.—80 A. Exciters.



MAIN TURBO GENERATOR AND BOARD

There is a 50 K.W. Standby lighting set, connected to a high speed Vertical Comp. Robb Armstrong Engine, size 9 x 14 x 7 in. stroke, 450 R.P.M. This 50 K.W. Generator can be put in on a peak load with any of the other machines or used for lighting at week ends.

The switch board consists of 4 Generator panels, 6 Feeder Panels and one Lighting Panel, and one synchronizing and Voltage Regulator Panel. The feeder circuits are protected by maximum current cutouts. The voltage regulator is one of the most important pieces of apparatus in the station, as the load swings are at times fully 60% of the station load and of frequent occurrence. The watt hour meters are at the rear of the board and there is ample room to work with a maximum of safety, there being 5 ft. in the clear. Under the switchboard gallery are situated the main oil switches and outgoing feeders. All electrical equipment is situated above the main floor. The basement being reserved for steam lines, generator air ducts, etc., the outgoing feeders pass from the power house to the main part of the plant through concrete tunnels. The switch board is made of white marble supplied by the Westinghouse Electric Co., and has a beautiful appearance, adding greatly to the brightness of the turbine room, which is done in white tile brick, 5 ft. high, the walls from there up are concrete with a coat of whiting. There is one 15-ton crane overhead for lifting purposes.

There are over 200 motors in continuous service in the main plant varying in capacity from 5 H.P. to 185 H.P. The conditions under which some of these motors are required to work is very severe, due to high local temperatures, and in some cases sugar deposits in the

VIEW OF OIL FIRED BOILERS

windings, thus closing the ventilating spaces almost entirely in a short time, which makes for short life of a motor. Every conceivable means is used to prevent this but without complete success, as once the deposit forms it cannot be blown from the windings like ordinary dry dust. It sticks in the crevices in a moist syrupy state and collects any dust that may be entrained in the ventilating air. Notwithstanding this handicap it is greatly to the credit of the Chief Electrician, Mr. Joseph Fawcett, that the plant has a well kept appearance, and is in continuous operation. Mr. Fawcett is only a young man, but has held the position of Chief Electrician for a number of years. All the electrical repairs are done under his direction on the plant, and he has an electrical testing laboratory, outfitted by himself.

Shipping Facilities.

The Company own their own lighter, and besides maintain a ferry service on the Harbor to accommodate their workmen. They have an extensive shipping wharf on the water front. Their shipping rooms and warehouses are equipped with the most modern labor saving devices for moving freight and piling.

Management.

The management of the plant is under Mr. F. A. Bodenheim, who before coming to Canada was connected with the largest Sugar Refineries of the Southern States.

Mr. John S. Misener, a Halifax boy, is assistant manager and chief engineer. Mr. Misener when a boy served his time as a mechanic in Halifax and made rapid progress in the Engineering profession, having been active in quite a few new installations and while yet a very young man, made good. He has been connected with the Acadia Sugar Refining Company for the past 14 years and has had the carrying out of various engineering improvements which attracted considerable attention from the engineering profession in Canada.

Engineers who are sufficiently interested in oil burning will be well repaid by a visit to this plant, if they can afford the time.

The writer wishes to express his appreciation of the courtesy of the Management in placing at his disposal blue prints and other data in connection with the plant.

Other Pumps.

For general service purposes through the power plant and refinery, there are fitted two Rees Ro-turbo pumps, each having a capacity of 5000 gallons per minute against 140 feet head. For fire protection there is a 1500 gallon Allis-Chalmers underwriter type pump, and a complete Grinell sprinkler system, dry pipe.

REGINA'S NEW TURBO GENERATOR

A 5,000 kw. turbo-generator has recently been installed in the city of Regina's No. 2 plant, commencing operation on November 9, 1920 The unit is a General Electric Curtis five stage 3,600 r.p.m. of latest design having a maximum rating of 6,250 kilowatts at unity power-factor.

The turbine is designed for 200 lbs. pressure gauge and 100 degrees F. superheat and a vacuum of 28 in. referred to 30 in. barometer and on test with lower steam pressure of 180 lbs. gauge and vacuum ½ in. away from barometer the steam consumption has proven as shown on Fig. No. 1. This shows that at 4,000 kw. load the steam consumption is 52,600 lbs. per hour or 13.15 lbs. per kilowatt hour. The consumptions at 2,000 and 1,000 kw. are also shown which are consistent and point to a no-load steam consumption of just under 6,000 lbs. per hour.

The turbine exhausts into a 7,450 sq. ft. Westinghouse condenser fitted with Leblanc air pump and condensate pump all direct connected to and driven by 40 h.p. motor at 700 r.p.m. This condenser receives its circulating water from a central circulating plant consisting of two 24 in. 12,500 gallons per min. Mather and Platt vertical shaft centrifugal pumps running at 265 r.p.m. and one 14 in. 5,000 gallons per min. Gywn horizontal centrifugal pump running at 430 r.p.m. These pumps are all direct connected to and driven by motors. The large pumps are driven by 110 h.p., G. E. motors, and the 14 in. pump by 40 h.p. Westinghouse motor.

Operating conditions are favorable and with circulating water at prevailing temperature of 40 degrees (in winter) a vacuum within ½ in. of barometer is regularly maintained with the small circulating pump operating alone.

The turbo-generator is an A T B, 6,250 kv.a., 3,600 r.p.m., 2,300 volt, and is fitted with temperature coils for indicating the hottest temperature points of generator.

The generator is connected to regular switchboard in plant (which is arranged for six generators and feeders with duplicate bus bars) through duplicate oil circuit breakers fitted with overload and reverse power relays.

Exciting current is from regular exciters of plant which are controlled by Tirrill voltage regulators.

The five-stage Curtis turbine consists of five wheels, the first wheel having a blade pitch diameter of 35 inches and the remaining four wheels having a blade pitch diameter of 51 inches, the length of blades increasing from a length of ⅞ inch on second wheel to a length of 9⅛ inches on last wheel.

Shaft glands are steam pocked, the leakage from high pressure end gland being tapped off from a point where pressure is above atmospheric pressure and led to low pressure gland by a large pipe passing through the turbine exhaust chamber. An unloading valve is fitted by which any excess steam from high pressure gland (other than the amount needed for the low pressure gland) is passed to the last two stages of machine.

The governing is done by progressive opening and closing steam valves admitting steam at full boiler pressure to more or less nozzles which act on the double row wheel of first stage. The valves are controlled by a cam shaft which receives its motion from an hydraulic plunger operated by the regular oil pressure of machine which is maintained at 70 lbs.

Oil pressure for machine is maintained by the regular gear type oil pump, direct driven by worm from turbine spindle or by a small turbine driven gear pump which is of the vertical shaft type, the whole auxiliary being a complete unit and hangs from top of oil reservoir with the gear pump submerged.

The generator has a direct connected exciter, but in the machine installed only overhung collector rings were provided. The field of the generator is solid, the winding being in radial slots with non-magnetic metal retaining wedges.

The shield packing where the shaft passes through the end bells of the generator is especially designed to prevent the suction of fans carrying oil vapors into generator. This packing is of a modified labyrinth type and air from the discharge side of generator fans is led down to the centre of this packing, this making a flow of air outward; or, in other words, this gland is air-packed. The bearing ends are also fitted with a similar connection and are supplied with air from generator fans to prevent oil vapors being forced out of bearings along shaft where it is difficult to handle and usually is drawn into any revolving parts of machine such as collector rings. With this arrangement fitted to bearings air is actually forced into bearing shells from the ends and is taken care of by a liberal vent pipe.

The coal consumption per kilowatt hour that may be obtained from a machine of this type, operating on a load curve as shown on graphic wattmeters, and in connection with a modern boiler plant, is shown by plant records for October, November and December of 1919, when the original machine carried all of plant load. The records show a coal consumption as follows:

October average load on machine, 35.1 per cent.—coal per kw. hour, 1.97.

November average loan on machine, 39.6 per cent.—coal per kw. hour, 2.07.

December average load on machine, 41.6 per cent.—coal per kw. hour, 2.03.

The coal consumed was Western bituminous of about 12,400 B.t.u. per pound for October and a mixture of Western bituminous and Saskatchewan lignite of approximately 11,000 B.t.u. per pound for November and December.

*Electrical News.

Overhauling and Adjusting in the Engine Room

In This Article the Steam End of the Ordinary Duplex Pump Is Described. The Steam Valve and Gear are gone into In Detail.

By "FITTER"

HAVING in the previous articles gone into the water end of the pump fairly explicitly, we will now take up the steam end, which is where a good many engineers slip up until they have acquired the requisite experience. The steam piston is a simple enough proposition, but the arrangement of the steam valve is different in practically every make of pump, and we shall illustrate a few of the principal makes and explain their design. Especially in the case of simplex pumps where the valve is worked from the pump rod is difficulty experienced, but when the principal on which these valves work is understood we are sure that there will be no trouble in keeping a pump working.

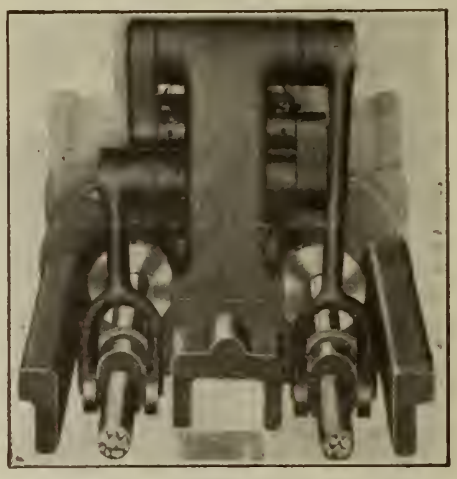
The Steam Piston.

The steam piston is almost invariably of the plain type, cast solid, with grooves turned in the circumferences for the reception of cast iron spring rings, or what are commonly known as Ramsbottom rings. The only trouble encountered with these pistons is that due to wear, and the remedy of course is boring out and the fitting of new rings, or sometimes a complete new piston and rings. The cylinder is usually counterbored for the easier introduction of the rings, and the piston is secured on the rod by two nuts and a cotterpin or taper pin. The rod is of course tapered for the reception of the piston in the usual manner. In larger pumps the piston is sometimes built up with a junk ring to carry the spring rings and a follower plate, and the rings themselves are sometimes made sectional. However, there is nothing in the piston itself to occasion any difficulty in the overhauling or running of the pump, the construction being self-evident when the pump is opened up for examination.

The mechanism for distributing steam to the pistons is, as we have said, of a very different order. There being no eccentric to give motion to the valve, except of course in the flywheel type of pump, a valve which is more or less self actuating has to be employed. Probably the most simple type of a steam valve gear is that employed on the ordinary duplex pump, in which the gear is so arranged that the pump rod on one side works the slide valve on the opposite side. The valves are of the simple slide type, with an exhaust cavity in the center. The flywheel type of pump has a slide valve exactly similar to any other steam engine with the addition in many cases of a Meyer cut-off valve. The simplex type of pumps are invariably fitted with a double type of valve, in which the movement of a small auxiliary valve by the pump rod furnishes a steam to throw over the main steam valve from side to side, and thus open the main steam ports to the cylinder at either end alternately. With this type of valve sometimes a very small alteration in adjustment will suffice to stop the pump, or make it work in a very erratic fashion, and it is therefore necessary for the successful engineer to have a clear understanding of the principles involved in their design.

Duplex Valve Pump Valve Gear.

In the usual type of duplex pump the valves are worked from levers operated by a spool and lever arm from the pump rod. The gear consists of a bracket which is bolted to a saddle cast on the frame of the pump between the steam and water ends, this bracket containing



ARRANGEMENT OF VALVE GEAR

two bearings in which the rocking shafts of the valve arms work. These bearings are offset in order to give working clearance, and are set one above the other. The lever arm which is driven by the pump rod is keyed on to one end of the rocking shaft, and the valve arm on the other, so that the lever on the right hand pump rod operates the steam valve on the left hand cylinder. The levers are of different lengths, that connected to the top rocking shaft being of course longer than that connected to the bottom. A short connecting rod connects the valve spindle with the pin on the valve arm, and the spindles are screwed at the end which enters the valve to take the adjusting nuts.

Owing to the position of the rocker shafts in the brackets, the valve arms are keyed on to the shafts in opposite positions to each other. That is the valve arm on the top rocker shaft looks downward, while that on the lower shaft looks upwards. This brings the valve arm pins in line with each other, and with the valve chest. It also has the correct effect for driving the valves, as we can see with a little study. Supposing the right hand cylinder is the one with the long lever, then the left hand valve will be driven from the top rocker shaft, and the valve will move in the same direction as the right hand piston. Now when the right hand piston goes forward the left hand valve will also go forward, and give steam to the left hand piston to drive it forward. When the left hand piston goes forward, however, its lever will drive the lower rocker shaft, and as the lever valve arm is keyed to this shaft looking upwards, it will move the right hand valve in the opposite direction to the left hand piston, thus giving steam to the right hand piston for the return stroke. It must be understood that in this type of valve gear the valve spindle nuts are given clearance from the valves, so that it is only when the respective pistons are nearing the end of their stroke that the valves are operated. The effect is to give quick opening to steam, and a full port opening while the piston is making its stroke. In the accompanying sectional illustration of a duplex steam valve the arrangement can be seen plainly, while the outside views gives the arrangement of the levers.

The steam cylinder has two ports at each end with the exhaust port in the middle, as is the usual practice. It will be noticed, however, that while the cylinder is double ported the valve is only single ported. The object of the two ports in the cylinder is to give a cushioning effect at the end of the stroke, and it is accomplished as follows:

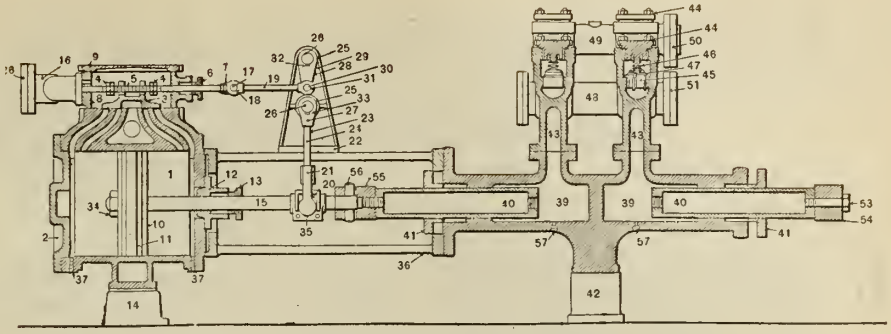
It will be noticed that the outside ports, that is, those at the extreme ends of the cylinders, lead into what is practically the clearance space. When the piston is approaching the end of its stroke it will completely cover the inside port, thus leaving only the end for the exhaust to escape from, and as the valve does not come back far enough to completely uncover this port, the restricted area has the effect of holding back the steam and building up the pressure to bring the piston to a stop gently. At the commencement of the stroke, this restricted port opening has the opposite effect, that is, it just gives steam enough to start the piston off

gently, and when the inner port is uncovered the full steam opening is obtained, after the piston has got well under way. This tends to smooth running, and absence of sudden pulsations.

Looking at the sectional view, it will be seen that the valve lever and valve arm that are shown are directly vertical, while the valve is in its mid position. In this position it just covers the steam ports or in some cases it leaves them barely cracked. The nuts on the spindle are a little way clear of the valve, and it will be seen that the distance they allow the valve to move in just sufficient to uncover the port at either end, depending on which way the valve is moved. This gives the key to setting these valves.

If the spool on the pump rod is in its correct place, and in pumps where this spool is held by a tapered pin, there is little chance of it moving, then when both levers are absolutely vertical, the valves should be placed so that they are just covering the steam ports, and the nuts adjusted so that the valves can move exactly equal distances on each side of the center line. If the spools are not secured by a taper pin but by a set screw, and they should happen to have been misplaced, then the piston should be set in the middle of its stroke, and the spool placed on the rod directly under the lever as it hangs vertically downwards. The center of the stroke can be found by moving to the poston each end of the cylinder alternately, and marking the rod at each end, and then dividing the distance between the marks.

The action of the valves is as follows: Suppose both pistons and valves are in mid-stroke. Both valves will be closed to steam, and the pump will not start from that position without outside help. If the pump has been in service for some considerable time, and the gear has a lot of lost motion, it will be still harder. However, the pump must be moved by a bar from its central position, that is one side must be moved. The pump here illustrated has the left hand pump rod driving the top rocker shaft, and that means that the right hand valve is operated by the valve arm that hangs down. Supposing now we take a bar and move the left hand pump rod forward. The right hand valve will be moved forward from its middle position, and the back steam ports will be opened to steam, the right hand piston starting to move to the forward end of the cylinder. The left hand valve will not move until the right hand piston has moved forward enough to take up the slack in the valve spindle nuts, and then as the right hand piston is operating the rocking shaft on which the valve lever is keyed looking upwards, the left hand valve will be moved backwards. This will open the ports on the forward end of the left hand clyinder to steam and thus the left hand piston will move backwards.



SECTION VIEW OF DUPLEX PUMP SHOWING VALVE

Now look at the right hand valve again. When we moved the left hand rod forward to give the pump a start, we had to move it sufficiently to bring the back valve spindle nut up to the valve, which means that all the slack is now on the frontside of the valve, and the valve will be open to steam on the back and exhaust at the front. As the piston moves forward it will cover the inside port, and slow down in its movement gradually as it comes to the end of the stroke. The left hand piston meanwhile will have been travelling back to the outside end of the cylinder, or back end if you like, and moving the top rocker shaft until the front nut on the right hand spindle comes up against the valve, and moves it backwards. This opens the front ports to steam on the right hand side, and the back end to exhaust, so that the right hand piston starts its return stroke, and in doing so moves the left hand valve forward to give the left hand piston steam and start it on its return stroke. It can readily be seen that if a great deal of slack is allowed to get in the various pins and bushings that make up the motion, a very unsatisfactory result will be obtained from the valves. In the duplex pump it is important to look closely after the oiling of the shafts and pins of the valve gear, and so prevent undue wear. The motion is so slight that many engineers seem to think that oiling is superfluous, while in other cases there is lots of oil all round and over the pump, but none in the places where it should be, owing to the small oil holes being blocked up. The slide valves should have a little lubrication till they get a good face, likewise the pistons, but after the pump is well bedded down, there is no use smothering it with cylinder oil which is expensive. The moist steam which is supplied to these pumps in most cases acts as a very efficient lubricator, and oil should be used just as judgment dictates, by the result of the periodical examination. There should be a regular time to examine the steam ends of pumps the same as any other apparatus. Unfortunately, too often pumps get stuck in dark dirty holes and corners where they wear their lives away in about one-quarter the time they should, purely from neglect.

When the bushings or pins of the valve gear get worn it is a very easy matter to have the bushings reamed out and new bushings fitted or spare parts secured from the makers. However, it is pretty safe to say that the average life of these parts could be doubled if proper attention was paid to their lubrication and cleanliness.

In subsequent articles we will take up the valve gears of various simplex pumps, this being a subject which we know from experience will be very welcome to many engineers.

TORONTO NO. 1 LODGE C. A. S. E.

Toronto Lodge No. 1, C. A. S. E., held a very successful meeting on Wednesday, June 8th, the occasion being the installation of officers for the ensuing year. The following officers who had been duly elected were formally installed in office:

Past President, Brother G. D. Bly; President, Brother S. G. Hall; Vice-President, G. Bones; Recording Secretary, R. G. Edwards; Assistant Secretary, W. T. Green; Financial Secretary, R. C. Leach; Treasurer, A. M. Wickens; Conductor, J. J. Wilson; Door Keeper, Ed. Golightly.

In addition to the installation of officers, two new members of the Lodge were initiated. It was announced during the evening that a lecture, illustrated with lantern slides, would be given on June 22nd, at 8 p. m., the subject being "Green's Economiser," the slides having been kindly loaned by Mr. Wellington, the local agent of the firm. Mr. Fenner, editor of Power House, will deliver the lecture.

CATALOGUES.

Messrs. Greene, Tweed & Co., 109 Duane street, New York, have issued a circular describing their "Poplar" packing, which has been designed for moderate steam and hydraulic pressures, that is below 100 lbs. per square inch. Low temperatures are also necessary where this packing is employed, and the packing has been designed for service where a moderate priced material can be used successfully. The packing is saturated with the firm's graphite grease compound, and then plaited solid.

A Course of Instruction for the Graded Certificate

A few more examples of indicator cards showing defects in the steam distribution are explained. Single cards only have been dealt with so far.

By T. H. FENNER

FOLLOWING up the interesting subject of indicator diagrams, we shall take up a few of the different varieties of defects shown on the cards. These defects do not always arise from the valve, but sometimes are due to the indicator itself, though these latter defects are usually very easily seen and corrected.

SHOWING EFFECT OF LEAKY VALVE

If you get a card which has a steam line looking like a perspective view of the Alps, don't jump to the conclusion that there is something radically wrong with the engine. Such a card is shown in Figure 1, and it is usually an indication of a tight or dry piston in the indicator, which causes a jerky motion of the spring. Taking an indicator diagram with too light a spring will also cause some funny effects, everything being greatly exaggerated. Make sure before taking a card at all that the cocks are clear or else you may easily get a card that has such a small area you will wonder what is going on, and how the engine carries the load. Too heavy a spring will make the card so small that you will not be able to distinguish anything from it. I think it has been mentioned in an earlier lesson about the drum of the indicator being free the whole stroke of the engine, that is, that the indicator drum does not come up against its stops before the engine reaches the end of its stroke. If this happens you will get an absolutely straight steam admission line, which doesn't happen in actual practice.

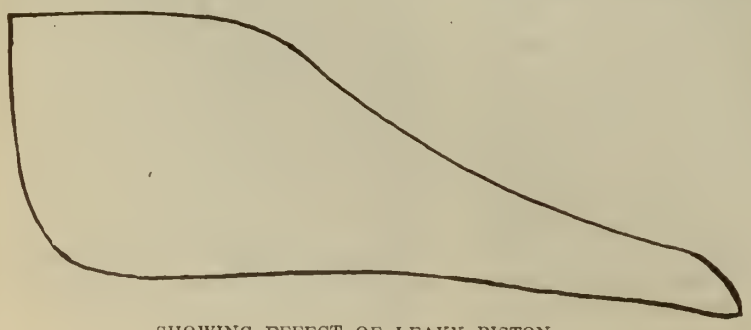
Supposing you have a valve that is not tight, that is, after cut off has taken place steam is still leaking through to the piston. The effect will be an expansion line with a hump on it, as shown in the illustration, while it is quite probable that the same effect will be shown on the back pressure line. The hump on the back pressure line may be caused by a leaky piston, allowing the steam to leak from the high pressure to the exhaust side of the piston, and raising the back pressure.

Drop valve gear engines invariably show a better card than slide valve engines, owing to the quicker closing of the valve when cut off takes place. This has the effect of making the corners sharper, thus improving the expansion curve. The illustration given shows what a card from a Corliss engine in good condition should be like. With the Corliss gear the quick opening of the valve also gives a very straight steam line, and any quick opening gear will do this as well as the true Corliss type. With the slide or piston valve one sees a sloping steam line. If this slope should be exaggerated it is due to the steam port not being wide enough for the engine, or the steam pipe leading to the steam chest not being large enough. Throttling produces the same effect. With a compound engine it is usually due to the receiver on the low pressure cylinder not having large enough capacity, or too early a cut off in the H. P. cylinder.

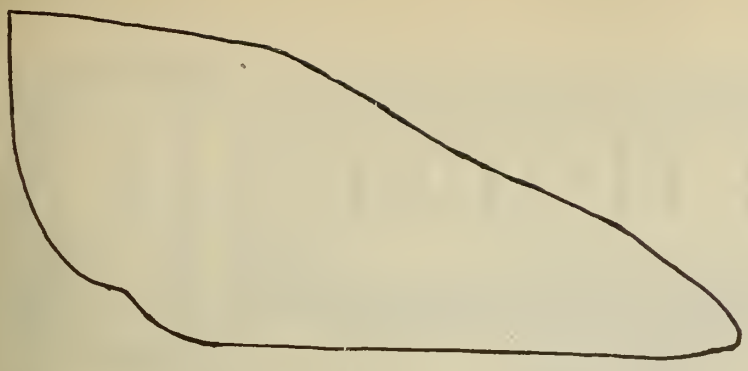
A loop at the top or steam line of a card is usually due to excessive compression, which causes the back pressure to raise above the initial pressure before the piston reaches the end of the stroke, and when the valve opens to lead the pressure drops to the initial pressure. Excessive lead will cause the admission line to rise above the initial pressure, but in this case it does not cause a loop, but merely a sort of peak at the corner of the card, as shown in the example in last issue.

GOOD EXAMPLE OF CORLISS ENGINE CARD
NOTE STRAIGHT STEAM LINE

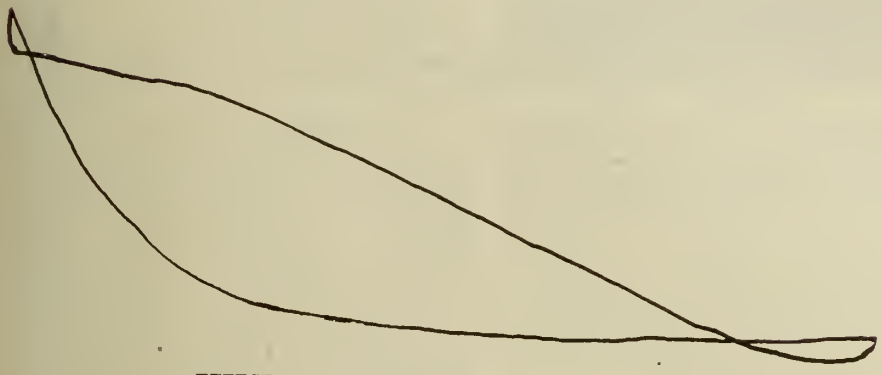
A case sometimes noticed is where there is a hump in the compression line, as shown in the illustration. This is caused by the top and bottom exhaust ports being open at the same time. This condition is sometimes found in high speed engines where there is minus exhaust lap, that is, the inside edge of the valve does not cover the ports when in mid-position, but leaves them just a little open. It thus happens that before the valve closes to effect compression, the exhaust port from the other side of the piston is momentarily open, and as the terminal pressure on the stroke is somewhat higher than the back pressure the higher pressure steam passes down to the other side of the piston. This causes a momentary rise of pressure, but the valve almost immediately closes and the compression curve starts. This



SHOWING EFFECT OF LEAKY PISTON

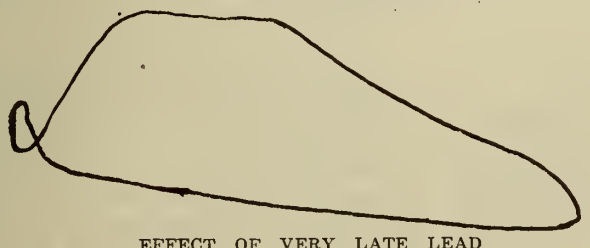


SHOWING EFFECT OF MINUS EXHAUST LAP



EFFECT OF THROTTLING

SHOWING HIGH COMPRESSION



EFFECT OF VERY LATE LEAD

is not often run across but there are examples, and several writers refer to them. Another example is where the loop occurs in the compression line. This is due to very late lead, so that when the piston is at the end of its stroke the steam which has been compressed starts to expand before the valve opens to admission. This results in the loop being formed as shown.

Sometimes a loop will be formed at each end of the card, at the top and bottom. This is due to early exhaust opening which allows the terminal pressure to fall below the back pressure while the compression curve beginning very early runs the back pressure up above the initial pressure.

Generally speaking, any deformity on a card can be traced to the source that caused it by close examination. The defects given above are those most usually run across. We have so far only spoken about cards from one end of the cylinder, but we will now take up the case where the cards are taken from both ends on the one card, and show how to correct them when defective.

BIG INCREASE IN POWER COSTS

How These Charges Have Been Increased During the Last Few Years

Cost of power occupied the time of Paul M. Lincoln, the noted American electrical engineer, in his address to the Electrical Engineering Institute at the Physics Building of the University of Toronto.

Mr. Lincoln dealt largely with fixed charges and operation ratio of electrical plants throughout North America. He showed that the price of every raw material had increased tremendously since before the war, and that this made an enormous difference in the price of operation of electrical plants then and now.

A Steady Increase

The actual operation cost dropped from 1910 to 1914, the average drop running about 5 per cent., but since 1915 there has been a rapid and steady increase in power house costs.

Mr. Lincoln estimated that the cost of a power plant to-day would run to 225 per cent. more than it did in pre-war times. This means that the public must pay, in the same ratio, these increased charges.

In plants which are operated by coal power, Mr. Lincoln showed that the coal costs during the past few years had considerably enhanced the cost of power. Further, he stated that the cost of labor in operation of power plants might be taken at 85 per cent. in excess of what it was in 1914. In total, he fixed the ratio of expenses in power operation from 1914 to 1920 as approximately 2½ to 1.

At the last meeting of the Montreal section of the Engineering Institute of Canada, an address was given by G. E. Newill, the general manager of the Robb Engineering Works, of Amherst, N.S., on the development of turbine construction, and in particular, on the achievement of the Dominion Bridge Co., of Lachine, in building a turbine power installation for the British-American Nickel Co. at Sudbury. It will be interesting to know that this is the first time that an engineering firm in Canada has accepted the challenge to construct a large power turbine of this character, running as it did into about a quarter of a million dollars and requiring all the precision of mechanical discernment and nicety that might be needed in the making of a full jeweled watch to be propelled by steam.

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An Irritating Practice

A CONDITION has arisen in some power plants which is causing a good deal of indignation among the operating engineers, and not without reason. This is the practice adopted among some managers and factory superintendents of having the steamfitter's crew perform alterations to steam piping and valves in the engine and boiler room without consultation or reference in any manner to the man who is responsible for the general upkeep and good condition of the plant. An instance is given where a steamfitter in repairing a blow-down pipe, substituted a smaller piece of pipe for the one he had taken out, in spite of the protests of the engineer in charge. The steamfitter's argument was that the smaller pipe would do just as well, and that he was not under the engineer's orders, anyway.

This condition is a very unfair one for the engineer in charge. The Government compels him to pass an examination and take out a license to show his competence to take charge. They will hold him responsible for any accident that may take place, and on the other hand the management holds him responsible for the economical and safe working of the plant in his charge. The steamfitter or plumber may be a very good tradesman, without having any particular knowledge of the principles involved in steam engineering operation. Any repairs or alterations on that plant should be done under the engineer's supervision, or else he should be relieved of any responsibility for what is done. This alternative is something he does not want, as it nullifies his position, and relegates him to a position which he has been steadily climbing out of. Repairs in the factory, where the engineer is not in charge of the whole of the machinery, may properly be done under the direct supervision of the foreman steamfitter, or where there is only one steamfitter employed, under the direction of the manager or factory superintendent. In the power plant itself the chief engineer should be the only one to say how and what should be done. If he is not competent to handle this work, he is not competent to handle the plant. Strictly speaking, where there is a force of steamfitters and plumbers employed in a factory, they should be under the direction of the chief engineer or the plant engineer if there be such an official. Where there is, and the power plant engineer is under the direction of the plant engineer, any work done in the engine and boiler room should be done under the direct supervision of the power engineer, for it is he who has to operate it, and be responsible for it.

Factory managers cannot expect to get the best out of their power plant if the operating head is subjected to petty annoyances of this nature. They would not send a junior clerk from the shipping department to make entries in the books of the cost department over the head of the cost accountant, and the power plant engineer is entitled to at least the same consideration.

Modern Boiler Settings.

THERE seems to be a good deal of doubt among some operating engineers as to the height of boiler settings, or rather, the height the boiler should be set above the grate bars. Time was, and not so very long ago, that a horizontal return tube boiler was set with the shell some 24 to 30 inches above the bars, the idea being to get the benefit of the heat. This notion, which was fundamentally wrong, has now been completely discredited, and boilers are set from four to five feet high, that is, H. R. T. boilers. Water tube boilers with horizontal tubes are set as high as twelve feet above the bars, it being a well recognized fact that there must be plenty of room for the gases of combustion to become ignited before they meet the comparatively cool surfaces of the tubes or shell of the boiler. The example of the candle and the piece of glass is as good as any for showing the correctness of this practice. If a piece of glass is held closely over the flame of a candle, close enough for the flame to touch the glass, it immediately becomes smoky. That is, a deposit of soot is formed on it which insulates it from the heat. If it is held further away from the flame there is no deposit, but the glass becomes heated much more rapidly. The same thing happens with the shell or tubes of a boiler. If set too close to the grate, the flame strikes them, and the gases are cooled off before they get a chance to complete combustion, and the surfaces become quickly covered with a carbon deposit. Good modern practice is to make the combustion space above the fire grate equal to the cube of the grate width. That is, with a grate, say 25 square feet, the boiler would be set five feet above the grate bars.

This is, of course, subject to modification, but is a fairly good approximate rule.

Build in Canada.—The English Electric Co. has announced its intention of extending operations to Canada, and it is understood that they will erect factories in Toronto for the manufacture of electrical machinery and equipment. The company, which is said to be the largest firm of its kind in the British Empire, and one of the most powerful industrial enterprises in the world, includes among its directorate Sir John Mansell, Lord Meston and representatives of John Brown & Co., Cammell, Laird & Co., Thomas Firth & Sons, and Harland and Wolff. M. Gordon F. Perry, president of the National Iron Corporation, Toronto, has been appointed chairman of the Canadian board.

We have received from Messrs. Dayton Dowd, Quincy, Ill., their bulletin No. 244 describing their line of centrifugal pumps, for all purposes.

Progress in New Equipment

BOILER FEEDING BY GRAVITATION

WE recently had an opportunity of investigating a new system of feeding steam boilers, which is being introduced by the firm of Royles, Limited, Irlam, near Manchester. The apparatus has been in use at the firm's own works for about three years, where it has given the utmost satisfaction, being both simple and reliable. In fact, there is an almost entire absence of moving parts. The system has been appropriately named "the Auto-thermal Feed." For its operation the apparatus depends upon gravitation, and it possesses the advantage that it can deal with water of high temperature, and can, therefore, make use over again of the water which has been evaporated, together with the water from a feed heater or from steam traps.

Fig. 1 shows the arrangement of the apparatus in conjunction with an overhead feed tank and exhaust steam feedwater heater applied to a Lancashire boiler. Fig. 2 is a sectional elevation of the two vessels forming the single lifting unit, which serve to collect and lift the water. Fig. 3 is an enlarged sectional view of the main steam valve which operates the lifter, and Fig. 4 is a similar section of a diaphragm valve the function of which will be described later.

The appliance consists of a lifter C, E—Figs. 1 and 2—and a feeder H—Fig. 1. The lifter receives all the water of condensation from steam traps, etc., together with the make up feed to the boiler, and lifts it into the feeder H, which is situated well above the boiler, whence the water gravitates into the boiler. The lifter consists of a receiving drum C with suitable tappings for the discharge pipes of steam traps, etc., one being allocated to the feed water heater shown on the right-hand side of Fig. 1, so that all the feed water is received into one common vessel. From the receiving drum all the water gravitates through the valve D, the opening of which can be adjusted, and the flap valve D^1—Fig. 2— to the lifter drum E, which is connected by means of the check valve G and a vertical pipe X to the feeder H, the pipe X also acting as a return pipe to convey the water from the feeder to the boiler through the valve K—Fig. 1.

The rise and fall of pressure in the lifter drum E, in performing its function, is utilised to admit steam from the boiler to the feeder at the proper time in the cycle of operations, and the perfect working of the apparatus is due largely to the manner in which this is done. The synchronisation of the two operations is of the utmost importance to perfect working. The steam and exhaust valve F—Figs. 1 and 3—has been specially designed for the purpose. It consists of an inlet valve L operated by a piston M. The spindle of this valve carries the exhaust valve N, the two valves being arranged that the movement of opening the steam inlet closes the exhaust outlet and vice versa. The steam, after passing through the valve F, is delivered into the lifter drum E through the perforated pipe shown in Fig. 2. A small hole O in the piston M of the valve F—Fig. 3—allows a certain quantity of steam to pass the piston and to put it into equilibrium. P is a poppet valve for exhausting the steam from the underside of the piston M under the action of the two tappet arms U and U^1—shown in Figs. 1 and 2—which in turn are operated by the float Z in the chamber E rising and falling as the lifter fills and empties. A pipe W connects the inside of the lifter with the underside of the diaphragm Q in the valve J—Fig. 4—the plunger of which, through the spindle V, opens and closes the double-beat valve R, S, T, which alternatively admits live steam to the feeder H or exhausts the latter under the rise and fall of pressure within the lifter. The supply of steam to the feeder must be direct from the boiler, but the steam for the lifter need only be of sufficient pressure to ensure the water being lifted into the feeder.

Assuming that the apparatus has just delivered a supply of water to the boiler, the feeder H will be full of steam at boiler pressure, the valve S being open to the boiler and the valve T—Fig. 4—closing the exhaust. Similarly, the lifter cylinder E being empty the float will be at its lowest position, and the tappet lever U^1 will be pressing the poppet valve P against its seating—as shown in Fig. 2 the steam pressure being thereby retained under the piston M, which is then in equilibrium, while the valve L is held against its seat. The exhaust valve N, being open, water entering the collecting drum C is free to gravitate into the lifter E, raising the float and eventually opening the poppet valve by the tappet lever U, thus exhausting the steam from below the piston M. The area of the top side of that piston being greater than that of the lower side of the valve L, the steam pressure causes the piston to fall and open the valve L, thus admitting steam to the lifter E and closing the exhaust valve N. The pressure in the lifter is conveyed through the pipe W to the diaphragm Q in valve J—Figs. 1 and 4—which is forced upwards,

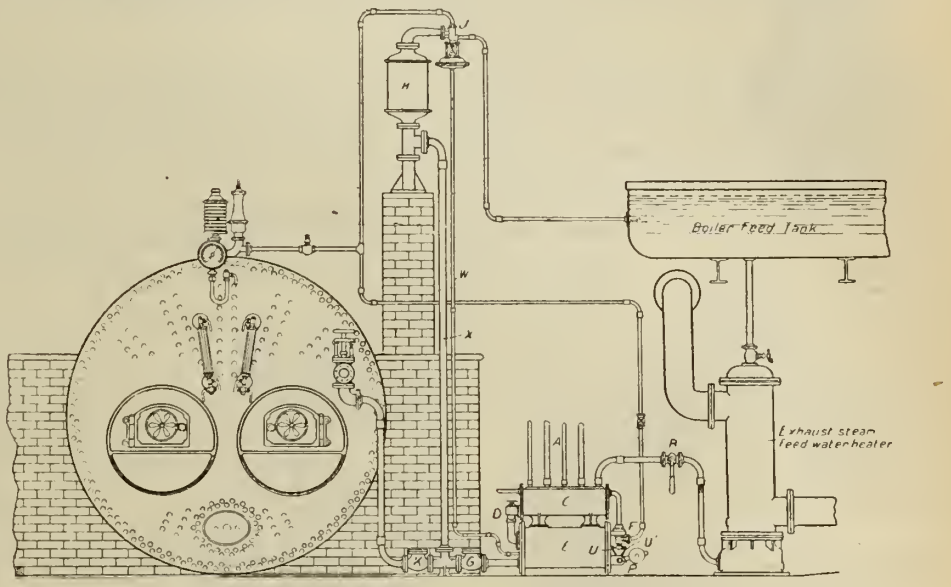


FIG. 1 GENERAL ARRANGEMENT

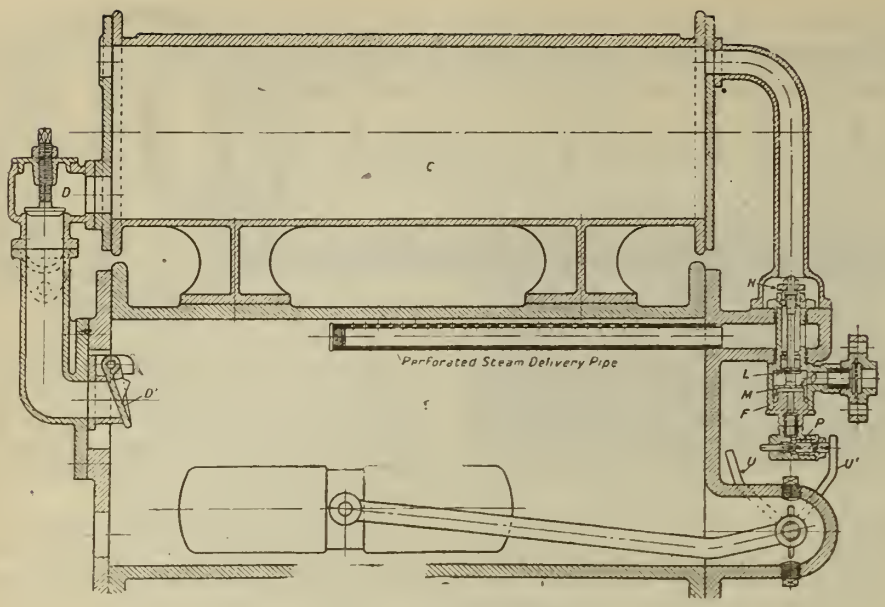
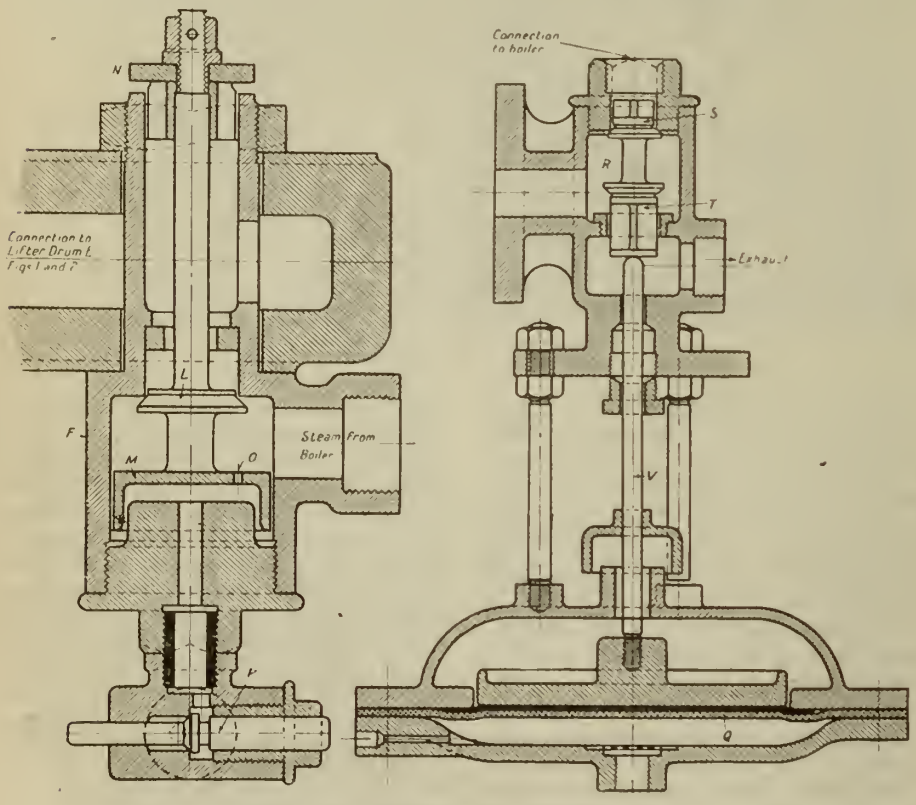


FIG. 2—LIFTING UNIT

closing the steam inlet S from the boiler and opening the exhaust T, and as soon as the pressure in the feeder H has fallen sufficiently the water from the lifter ascends into the feeder through the pipe X. The float in the lifter then falls and closes the poppet valve P again. Steam pressure then accumulates under the piston M through the hole O and the valve L is closed again, thus shutting off the steam from the lifter drum E and opening the exhaust valve N. The fall of pressure in the lifter brings down the diaphragm Q in the valve J, closes the exhaust valve T, and allows steam at full boiler pressure to pass the valve S into the feeder H and drive the water into the boiler through the pipe X and the non-return valve K, thus completing the cycle.

The proper working of the appliance is largely due to the effective way in which the exhausting or admission of steam to the feeder H is controlled by the lifter E. A considerable amount of experimental work was necessary to perfect the main steam valve F—Fig. 3—and the valve motion has been so designed that it cannot stop in mid-travel. The valve L holds to its seat until the reduced pressure on the underside of the piston M causes the pressure on top of the piston to pull the valve L away from its seat.



FIGS. 3 & 4—SECTION OF VALVES

The apparatus is made in various sizes, from 250 gals. to 3,000 gals. per hour. That in use at the makers' works is of the 1,000 gals. size, and gives two strokes or pulsations per minute.

ERROR.

In the article on Low Pressure Heating Systems which appeared in the issue of May 20th, page 39, column 3, the formula for the area of a safety valve was incorrectly stated. The correct formula is

$$W = \frac{a\,(P+15)}{.22} \quad \text{and} \quad P = \frac{.22W}{a} - 15$$

ANNOUNCEMENTS

The Jos. W. Hays' Corporation have issued a folder describing their various appliances for effecting fuel economy. These include the well known CO2 recorder, draft gauges, gas analyser, boiler setting compound, etc. A postcard ready addressed to the corporation and bearing spaces for data on boiler plants is included, for those who wish to obtain further information on the articles included in the folder.

* * *

The Combustion Engineering Corporation have recently been compelled to increase their office space in the Philadelphia district, and also inaugurate a new service department. The new office is located on the 10th floor Finance Building, Philadelphia, and is under the management of Mr. W. C. Stripe.

* * *

Jones & Glassco, Montreal and Toronto, announce that they have been appointed the sole agents in Canada for Steel Belting. This belting, while comparatively new in Canada, is largely used in Great Britain, for power transmission in industrial plants.

Formed New Connection.—D. J. Beatty, formerly advertising manager for the Northern Electric Co., has resigned to go into partnership with G. L. MacGillivray in the G. L. MacGillivray & Co., Ltd., 103 Notre Dame Street West, Montreal. This company was recently formed to look after the selling interests of the following firms in Eastern Canada: Edwards & Co., Inc., American Insulator Corporation, Waterbury Manufacturing Co., Chase Metal Works, Parker Supply Co., Inc., R. M. Radio Co. of London, Eng., the Prometheus Electric Co. For some time prior to enlisting for overseas service, Mr. Gordon MacGillivray was assistant supply sales manager for the Northern Electric Co. at Montreal.

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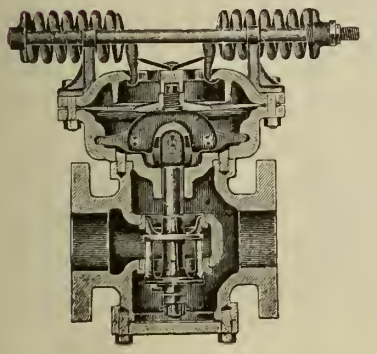
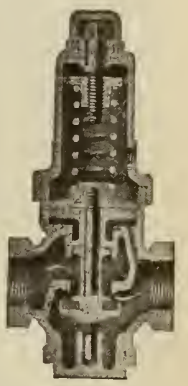


ENGINEERING skill and a broad, practical knowledge in the manufacture of valves have never been applied with better success than in the design of Foster Pressure Regulating Valves, of which there is a special type for each particular requirement.



Foster Pressure Regulators are simple in construction and their noiseless, friction-less operation insures long life. Other features are: Renewable seat rings, ample steam capacity, no small parts to clog, ease of adjustment, accessibility for repairs, small movement of diaphragm, parts of drop forged and case hardened steel, etc.

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OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

SIMPLE OR COMPOUND HOISTING ENGINE

Question.—What is the difference between a simple hoisting engine and one with a second motion gear?

Answer.—An ordinary two-crank hoisting engine is composed of two cylinders of equal size mounted on each gear which is keyed to the hoisting drum. In the case of a second motion engine the engine is arranged so that it can drive through compound gears instead of direct. In this case the pinion on the crank shaft is mounted on a clutch, and when the engine is running in single gear the clutch is engaged with the pinion driving the gear as in the ordinary single engine. When the compound gear is used this clutch is disengaged and the pinion is allowed to run free on the shaft. A second pinion at the other end of the shaft also mounted on a clutch is put in gear with a spur wheel on a second motion shaft, and on the other end of this shaft opposite the main drum pinion there is a third pinion also furnished with a clutch. This clutch is engaged and drives the main drum spur gear.

MEANING OF CORROSION

Question.—What is meant by corrosion?

Answer.—General corrosion is the oxidization of metal under the action of air and water, and is a species of slow combustion. It can be prevented by careful attention to the surfaces in danger of corrosion, keeping them well painted with protective paints, such as red lead. Where the surfaces cannot be painted as in the heating surface of a boiler or any part of a boiler internally below the water line then the metal must be kept clean and free from deposits of any kind. This particularly applies to the form of corrosion known as pitting, where the oxidization is localized into small pits, which gradually spread. Electrolytic action is caused by electrical discharges between different metals in the presence of water, and can be prevented by introducing a material that will be more susceptible to the electric discharge than the metal of the boiler. This is usually done by hanging zinc plates in the water space, the hangers making good metallic contact with the stays, tubes or shell of the boiler.

BLOWING DOWN BOILERS

It seems strange that there should be a difference of opinion about the proper time to blow down a boiler, assuming of course that the object of blowing down is the removal of mud or scale forming matter.

We are told by some book writers, some boiler inspectors, and occasionally an engineering magazine that the proper time to blow down is when the fires are dead, and we are told as proof of the correctness of this theory to watch the process of emptying a bath tub, the idea being that the emptying of a bath tub is the analogy of blowing down a boiler. This is so to a certain extent and would be a perfectly satisfactory illustration to anyone who is able to make the proper deductions from the evidence it gives.

The proper time to blow down a boiler is when the fires are active, because then the mud is in suspension in the water and any percentage of water blown out carries the same percentage of mud. This does not include matter that is so light that it will float no matter how rapid the circulation may be. Only a surface blow-off will get such.

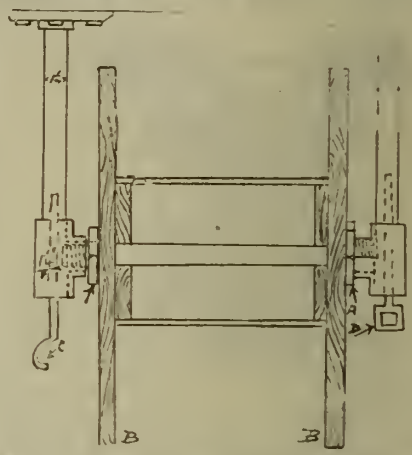
When the fires are dead circulation is dead and the mud finds a resting place on either the tubes or the shell and blowing down will not remove it.

This may be proved by any engineer who wishes to know the truth, if he will remove the top man hole plate before emptying the boiler for washing out. He will find the water clear and a deposit of mud on the tubes. When he opens the blow-off he will see the water lower without a particle of mud being moved until the water begins to uncover the tubes. Then the mud will be carried off the upper row of tubes. When the water begins to uncover the next row the same thing occurs, and so on at each successive row. When the water level gets down near the bottom the velocity of flow from the front of the boiler toward the rear becomes rapid enough to carry the mud deposited there along with it.

It is this stage of emptying a boiler that is illustrated by the emptying of a bath tub.—R. McLaren.

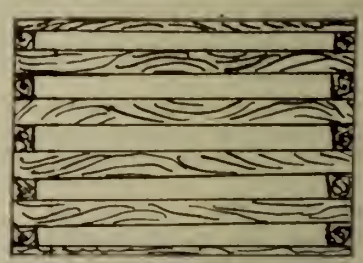
MAKING A HOSE REEL

The hose reel illustrated here will compare favorably with many more expensive types, and is easy to build and very substantial. A piece of 1-inch iron



PLAN VIEW OF REEL FASTENER TO WALL

pipe is used for an axle, and two strips of round wood with pieces nailed on around them form the drum. The 1-inch pipe is held in the drum by locknuts "A." The sides can be made of wood, or round pieces nailed to the drum as at "B." The brackets consist of two flanges, two 1¼-inch tees, and two



MAKE UP OF DRUM

pieces of 1¼-inch pipe. The reel can be attached either to the wall or ceiling. A hose wrench and hydrant key are shown at "C" and "D."

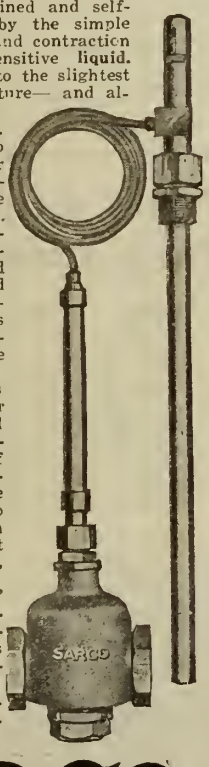
Secure United States Work.—In competition with eight other elevator companies, the Fegles Construction Co., the only Canadian firm tendering, received the contract for the construction of an eighteen hundred thousand bushel elevator in Brooklyn, N.Y. The elevator will be known as the Barge Canal Terminals at Gowanus Bay, Borough of Brooklyn, the contract being $1,500,000. The terminals are to consist of fifty-four concrete tanks, a boiler house and power house, together with installation of machinery, the whole to be completed in every detail and ready for occupation by September 1, 1922.

Why Gauge Temperature By Guess?

THE man trying to watch and control temperature may keep it right four times out of five—perhaps nine times out of ten—but sooner or later he is sure to slip up—and every time he does a batch of expensive material is either spoiled or damaged.

Why depend on mere guessing—on hit or miss uncertainty, when you can have absolute certainty?

A single batch of spoiled material, a single process gone wrong through the uncertainty of guessing, will frequently amount to several times the cost of a Sarco Temperature Regulator—an automatic heat control that absolutely guaranteed to be accurate and dependable under all conditions.



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PLANT WILL HAVE GREATER CAPACITY

Changes Being Made To Give Larger Output for Electrical Apparatus.

Owing to the substantial development that has taken place in the electrical equipment business of the Canadian General Electric, it has been found necessary to take over some of the space that has formerly been included in the Allis-Chalmers plant.

This will be utilized after the necessary equipment has been secured, some of which will be taken from other plants, for the making of transformers.

Mr. J. J. Ashworth, general manager of the Canadian General Electric, intimated that it would take some time to finish making the change, but that when completed the plant would be capable of much greater production of electrical equipment.

The plans of the company also call for the disposal of a large amount of used machinery, part of which was used in their war contracts.

Rumors that were prevalent some months ago regarding a large match factory that was to be built in Canada by British manufacturers seem now to be on the point of consummation, as it is stated that Sir Alexander Maguire, of the firm of Maguire, Patterson and Palmer, will shortly come to Montreal to negotiate for the erection of the necessary factories in this district.

* * *

BRANTFORD FIRM TAKES NEW LINE

Darling Valves Will be Made at Plant of the Dominion Steel Products in Short Time.

BRANTFORD. — Announcement was made of the taking over by the Dominion Steel Products Co. of the Darling Valve and Manufacturing Co. of Williamsport, Pa. This company makes a line of valves for waterworks, oil lines and other pipes and hydrants, and has a reputation very high in Canada as well as in the United States, where the parent plant is located. Owing to the high duty on their products, which in the United States sell for a higher price than the products of their competitors, the market in Canada was limited, yet despite this they were used considerably, Brantford and Ottawa being among the cities which utilized their goods.

It was reported at the D. S. P. that the company was already receiving business in the new lines. The signing of the contract means that No. 1 and No. 2 plants will be opened for the manufacture of these goods as soon as necessary changes can be made, particularly in the foundry. It will take three or four weeks to bring these changes into effect and to get the plant upon a full production basis.

NOVEL USE FOR TRACTORS.

A sudden strike among the employees at the electricity station in a British town interrupted the supply of current to the local factories and thus brought them to a standstill. Help came, however, from an unexpected quarter. One of the factories was engaged on the mass production of tractors for agricultural and other purposes; and within a few hours a number of tractors were employed to supply the necessary power in this factory. Twelve tractors were belted up to a shaft from which several motors were driven as dynamos, this novel installation giving an average output of two hundred horse-power. Other tractors were used to drive machines directly. When the news of this got about, demands for the tractors came from other factories, and the emergency service so provided greatly discounted the effect of the strike.

ELECTRIC SOLDERING IRON

The use of the electric soldering iron to manufacturers in general is too self-evident to require any comment, and a new type of such an iron has been offered to the trade by the Vimy Supply Co., 567 College St., Toronto, Ont.

This iron has been approved by the H.E.P.C. and Power House has had an opportunity of handling one. It is very compact, has a push button control in the handle, and the copper bits are readily removed and new or larger bits inserted if required. This is accomplished by means of a suitable socket. The iron heats up very quickly, and the control button in handle regulates the heat. One button is painted red. By pushing this in the circuit is made through the element. With every iron is given a guarantee for one year, also a few hints to iron users in general that are well worth following out.

POINTS FOR TWIST DRILL USERS

If the drill chips on the edge it indicates that the lip clearance is too great and fails to support the cutting edge. This may be because the drill is too hard. It is advisable to ease off on the feed and watch the grinding.

If it splits in the web, it is either ground with improper centre lip angle or the feed is altogether too heavy. The centre lip should be at about 45 degrees to the cutting lips of the drill. The drill is in best condition when the chip comes out in a close coil.

If the outer corners wear it shows that the speed is too high and it should be reduced. This is particularly noticeable in drilling cast iron.

Drilling cast iron can be done at a little faster speed than for steel, but the corners must be watched.

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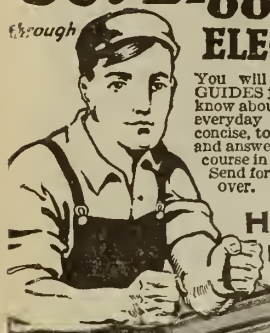

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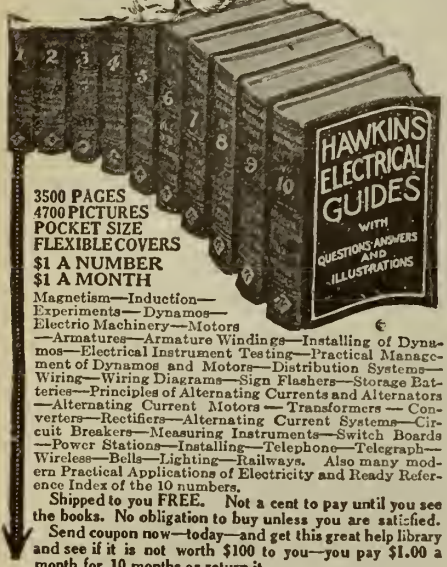

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STATIONARY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers. Corliss and all classes of stationary engines, compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St., Toronto.

ONE FIRST-CLASS SAWMILL MILLwright wanted at once. Apply, giving references and wages wanted to Box 613, Globe, mentioning Power House.

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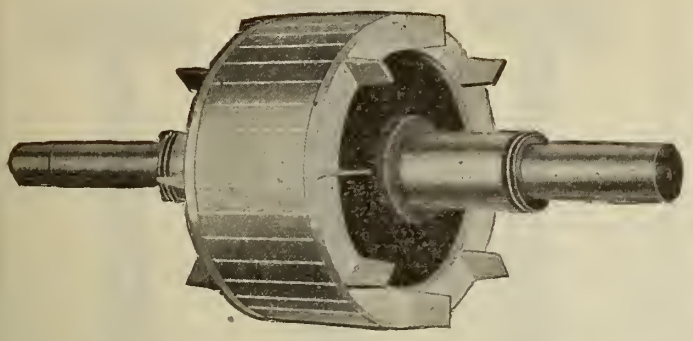

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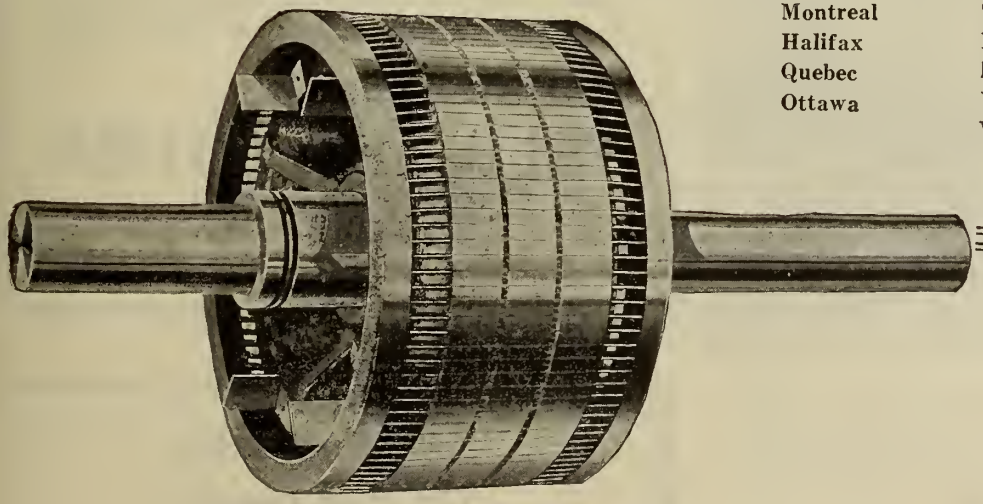

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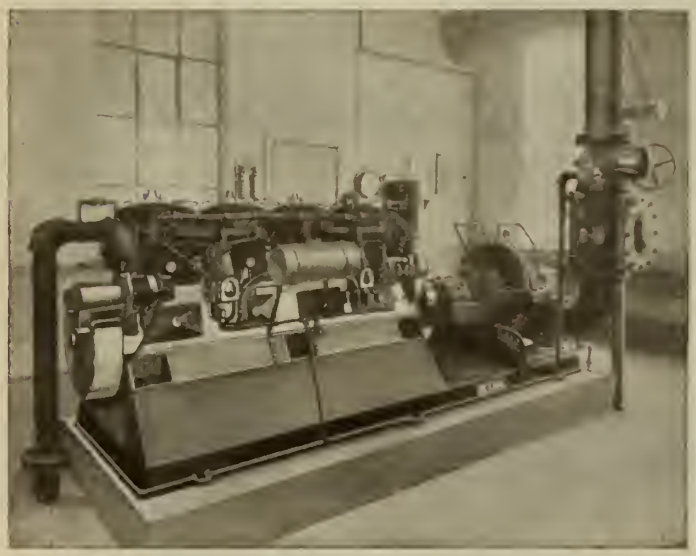

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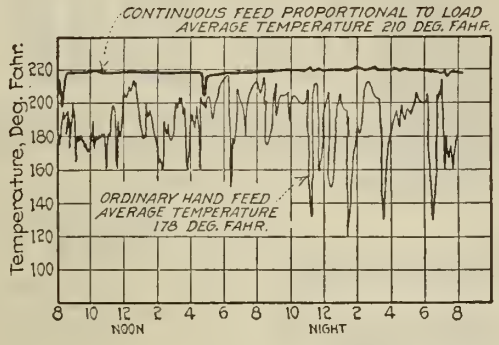

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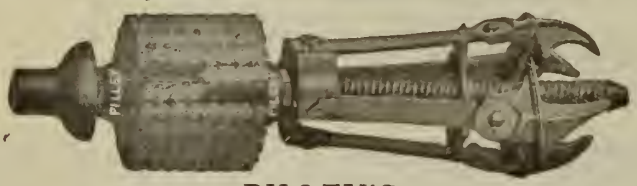

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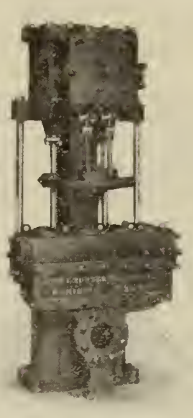

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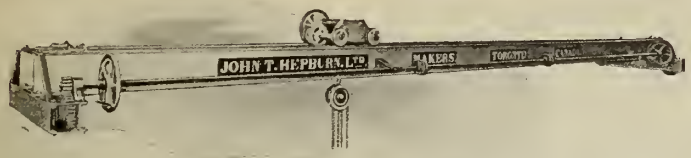
Double I Beam

Send Us a Plan of Your Shop



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are built with single or double I-Beams, in a range of sizes from 1-4 ton to 20-ton capacity. The Hepburn Trade-Mark is your guarantee of strength, efficiency and long service. Also a full line of Pumps, Vertical Engines, Compressors, Iron Castings, etc.

Send us a plan of your shop, stating the width, the height, the load to be lifted, and the headroom available, and we will show you how a crane which will save you money, could be installed. It won't cost you a cent to get this information, and we urge that you make a survey of your shop at once. The result may reveal many possibilities that will surprise you.

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Engineers and Iron Founders
18-60 Van Horne St., TORONTO

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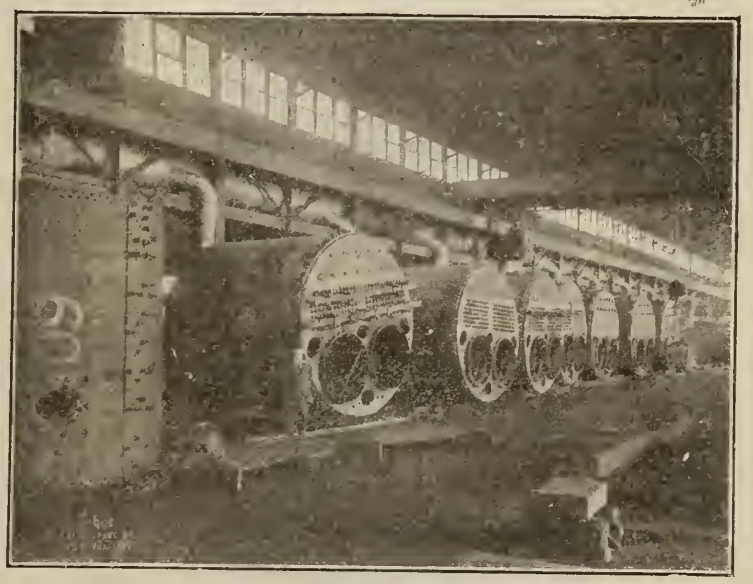
¶ No business can do without it—either in a literal or a figurative sense.

¶ The shop that doesn't improve or renew its Boiler equipment now is losing a valuable opportunity — our service is at its best and new, low prices are available.

¶ We make every type of Boiler, steel plate work, castings, etc.

¶ Write us to-day.



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Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
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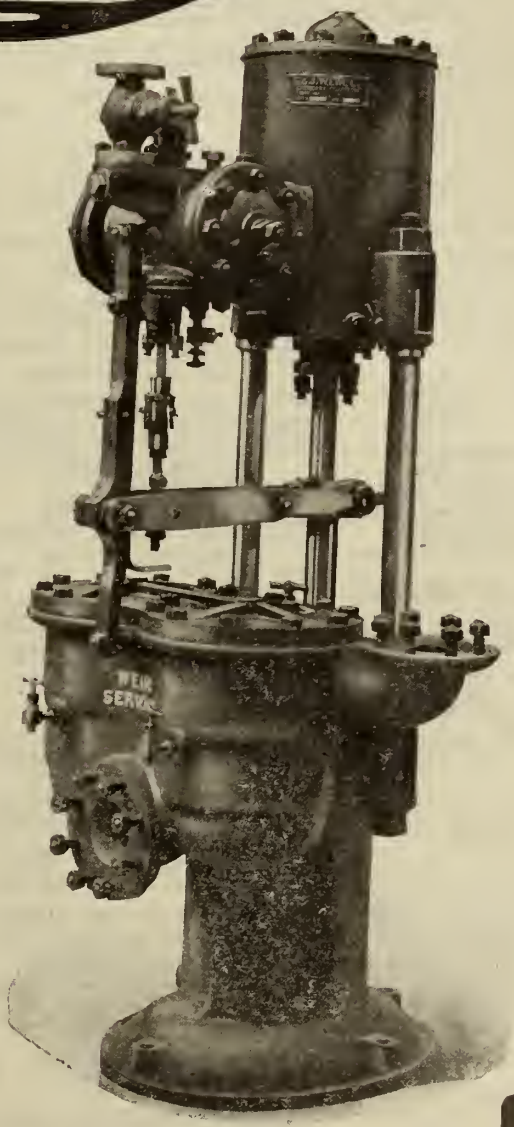

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Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, ELECTRICAL—ALL TYPES
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER BELTING
W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Green's Economiser, Ltd., Toronto.

METERS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd, Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

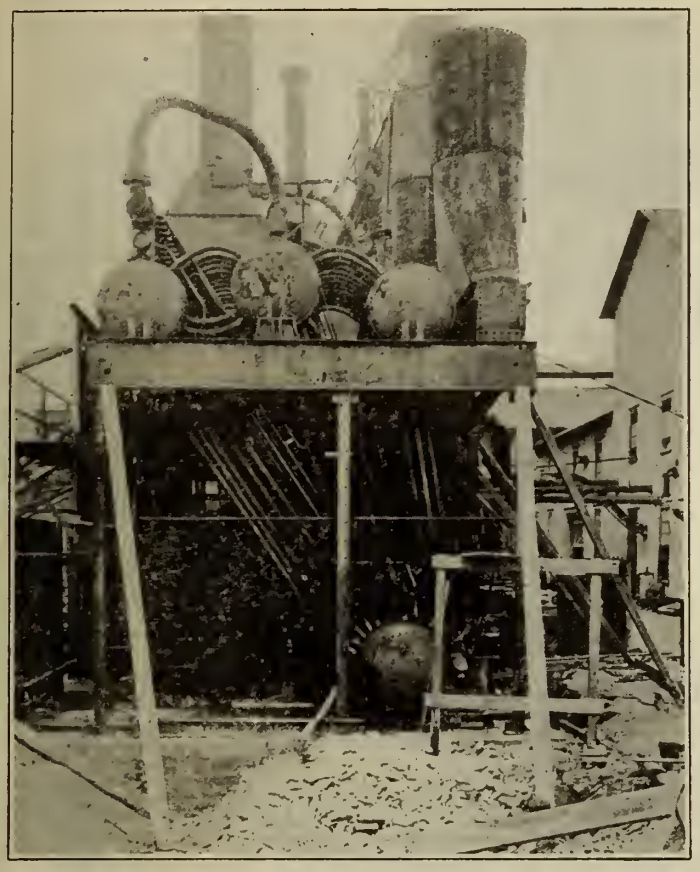
OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal
Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton



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Beldam Asbestos (Canada) Co., Toronto.
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Can. H. W. Johns-Manville Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
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MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

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Homestead Valve Mfg. Co., Pittsburgh.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Darling Bros, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
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RADIATOR TRAPS
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Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
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S. F. Bowser Company, Ltd., Toronto.

REBOILERS
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W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

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S. F. Bowser Company, Ltd., Toronto.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Green's Economiser, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.
Jos. W. Hays Corp., Michigan City, Ind.

RECORDEDS CO2
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.
Uehling Instrument Co., New York, N.Y.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

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McDonough, J., 323 Markham St., Toronto

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

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Beveridge Paper Co., Ltd., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
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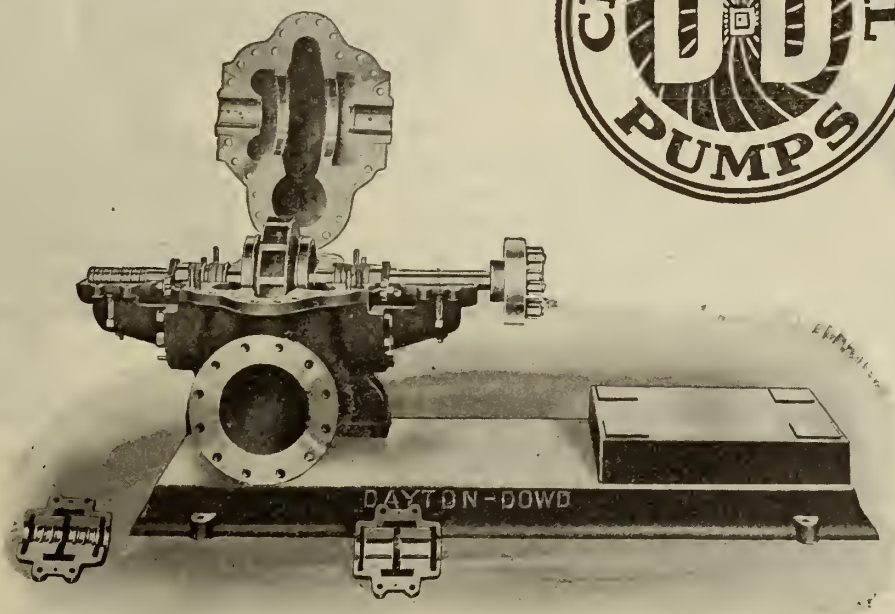
Dayton-Dowd

CENTRIFUGAL DD PUMPS



Type C S Single Stage Double Suction Centrifugal Pump

Showing Upper Half of Casing Raised—Note Ease of Access to all the Working Parts.

Because of its many advantages over other pumps, the centrifugal type is receiving the preference in the majority of installations. Dayton-Dowd centrifugals embody the most advanced principles of design; they represent the most modern high-grade standardized centrifugal pump possible to produce.

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The features of this pump are many in number—bulletin 240 explains them; send for it.

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LIMITED

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STEAM AND POWER DRIVEN
DURABLE PUMPING EFFICIENT
MACHINERY
PISTON AND PLUNGER TYPE

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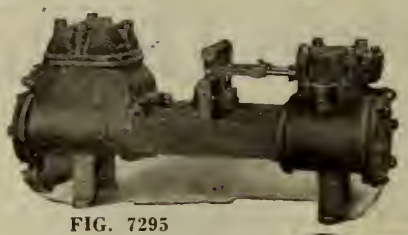

FIG. 7295
Packed Piston Boiler Feed Pump.

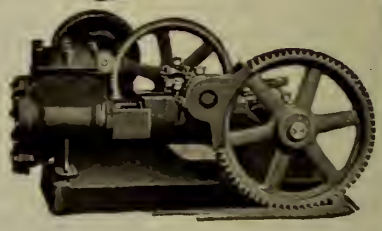

FIG. 7404
Made in piston and outside center packed plunger pumps for both top and side motor mounting.

UNIFORM SPECIFICATIONS of a high standard govern the production of all McGowan Duplex Steam and Power Driven Pumps, which are built on the interchangeable system of parts, under the same rigid inspection inaugurated in our works by the United States Shipping Board Emergency Fleet Corporation, in connection with the production of pumps for the Emergency Fleet.

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FIG. 7439
Packed Piston General Service Pump

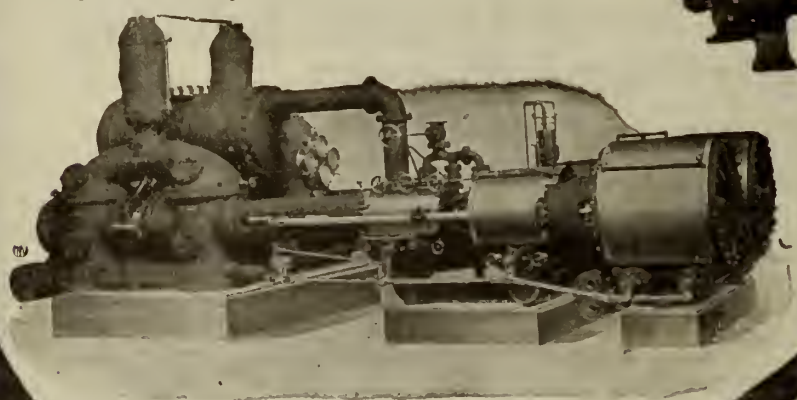

FIG. 7362
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fulfill identical purposes. Mason Reducing Valves and Regulators, Bundy Steam Traps and Reilly Water and Grease Appliances are a constant insurance of free-from-worry service and an absolute guarantee of reliability and positive action.

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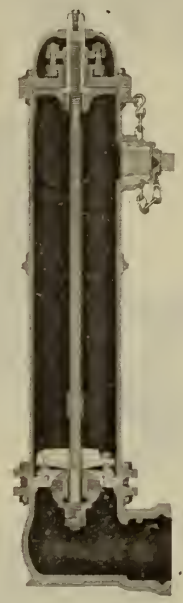

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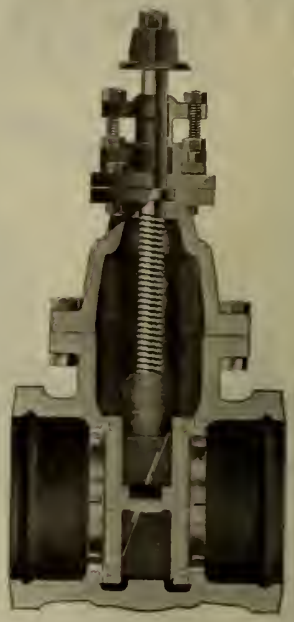

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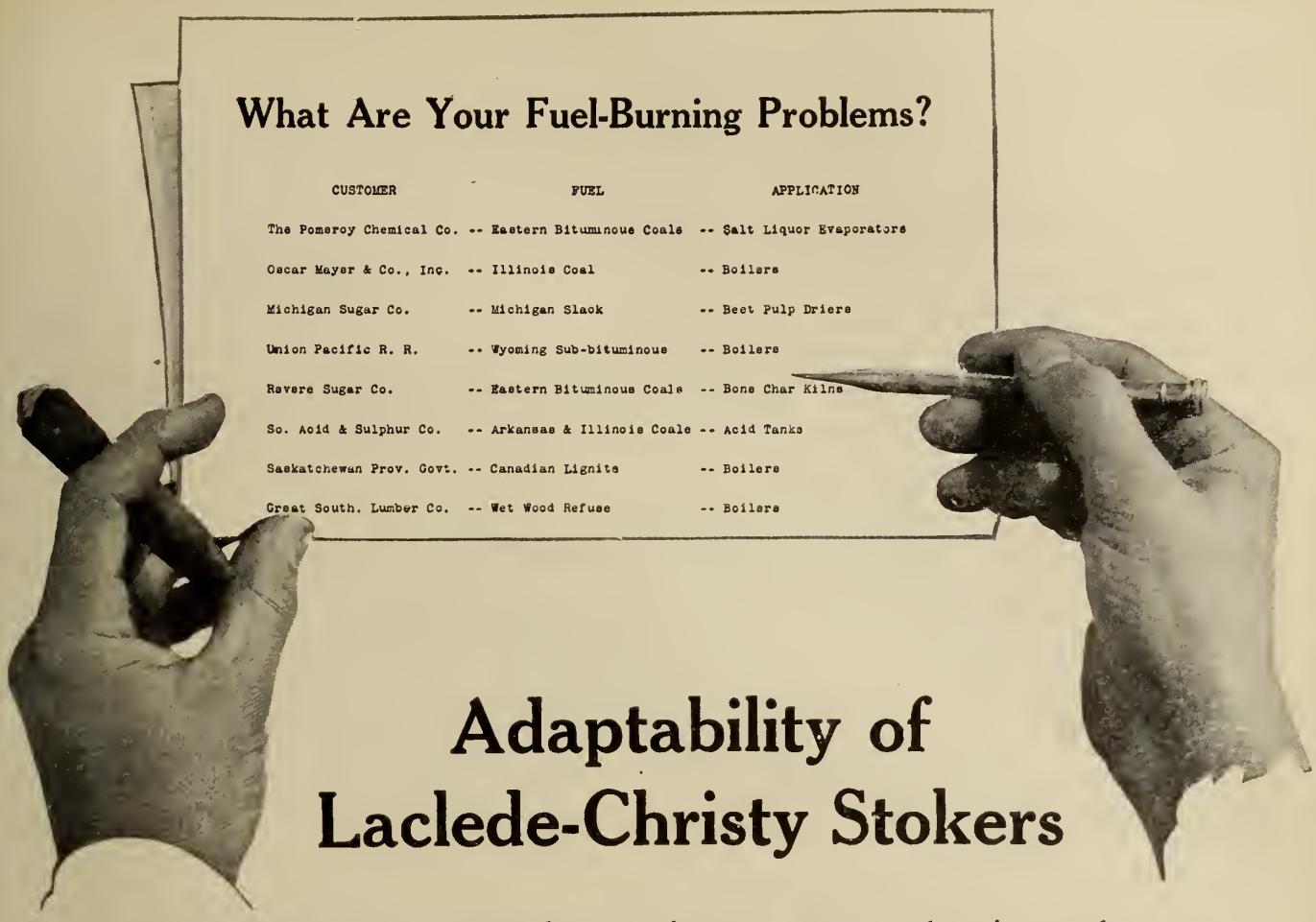
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E-156

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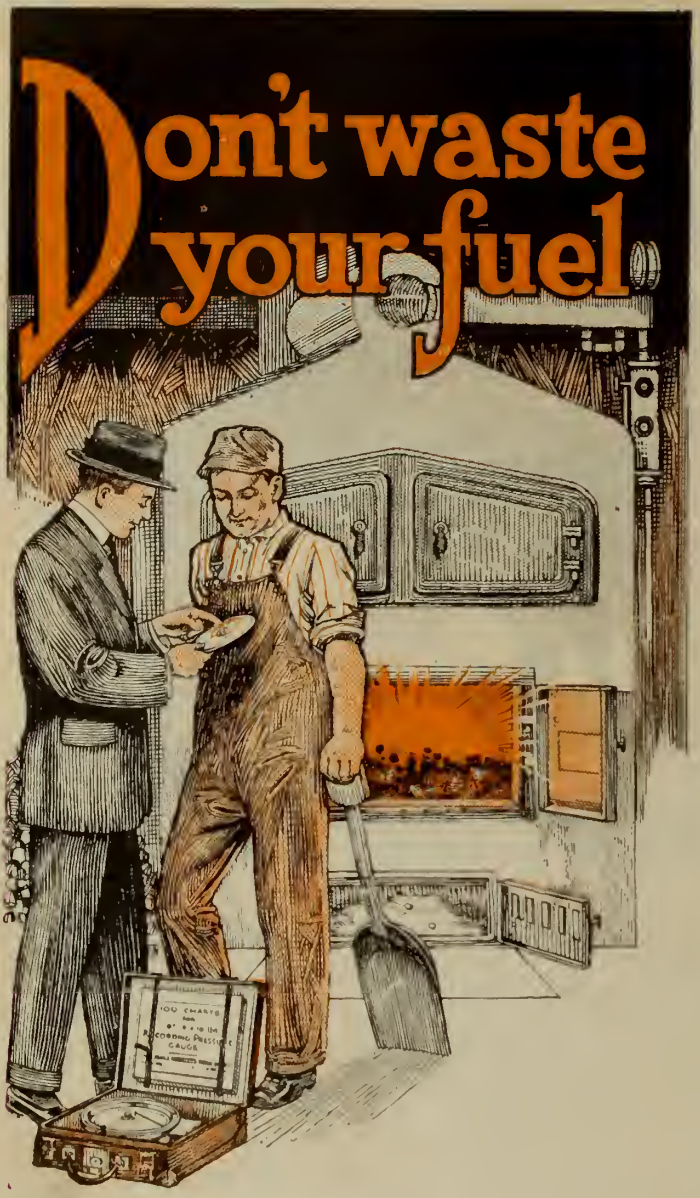

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"Of course, you have a high opinion of your ability as a fireman.

"Can you convince the 'boss' that you are the best man he could get for the job?

"This Morrison Pressure Recording Gauge is just the thing to do your convincing. It takes a continuous record of your steam pressure—thus showing exactly that you have kept it up to the mark every hour of the day. Don't you think you *need* this proof of your ability?"

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(*two days later*)

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"Boss": "It looks that way. But, how do you know the gauge is correct?"

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A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

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Vol. XIV. No. 13. Publication Office, Toronto—July 5, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

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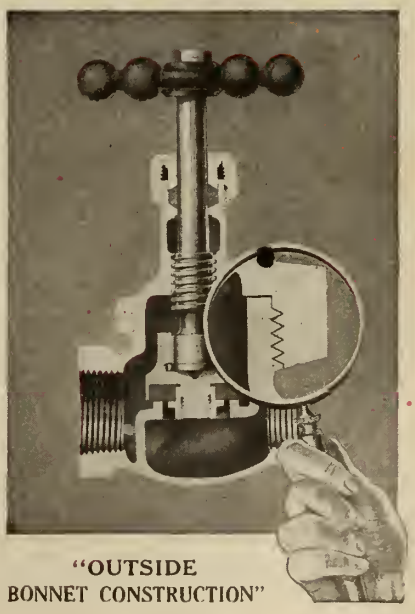

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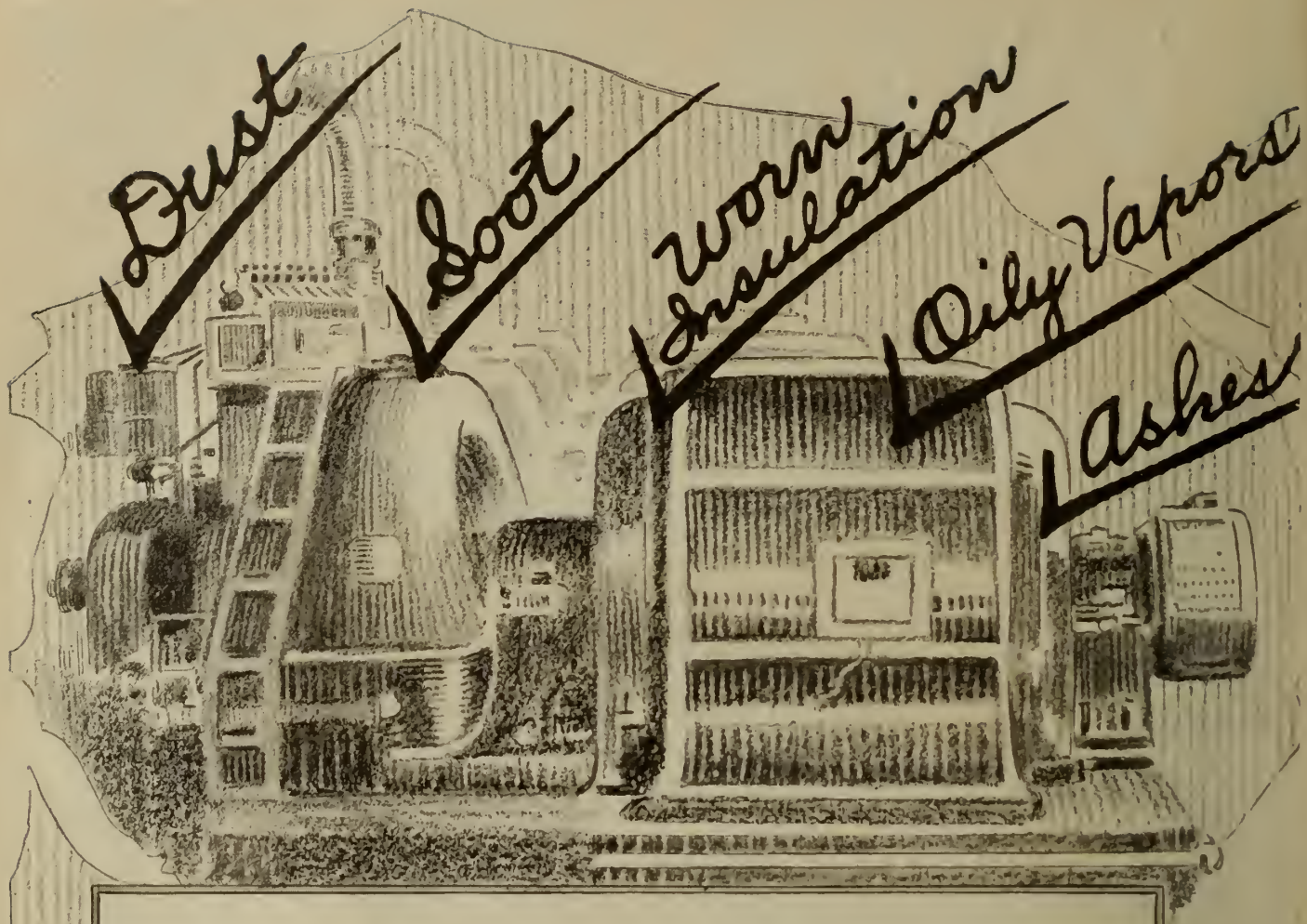

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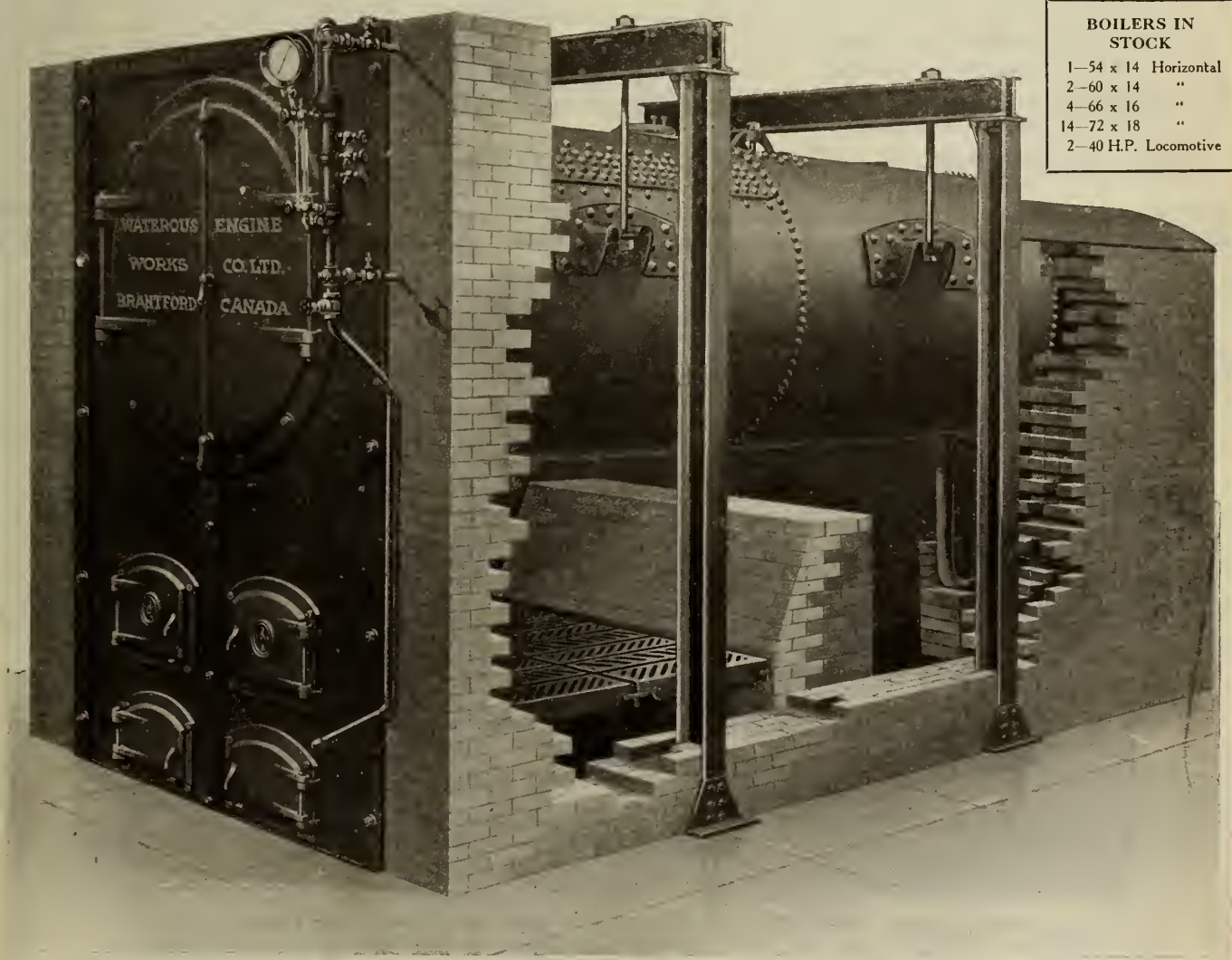
2—40 H.P.	Locomotive



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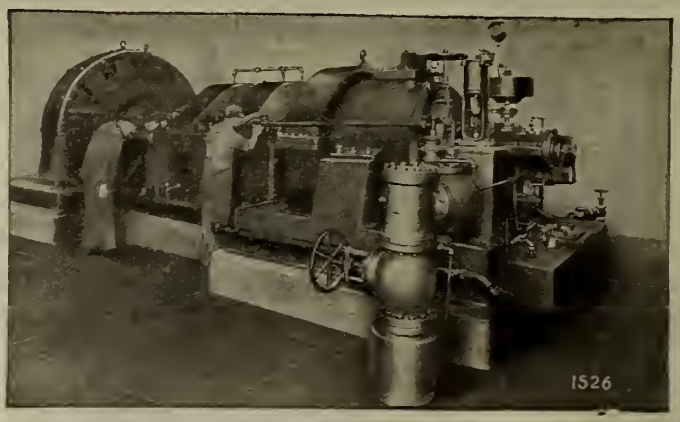
Power *For* Auxiliaries



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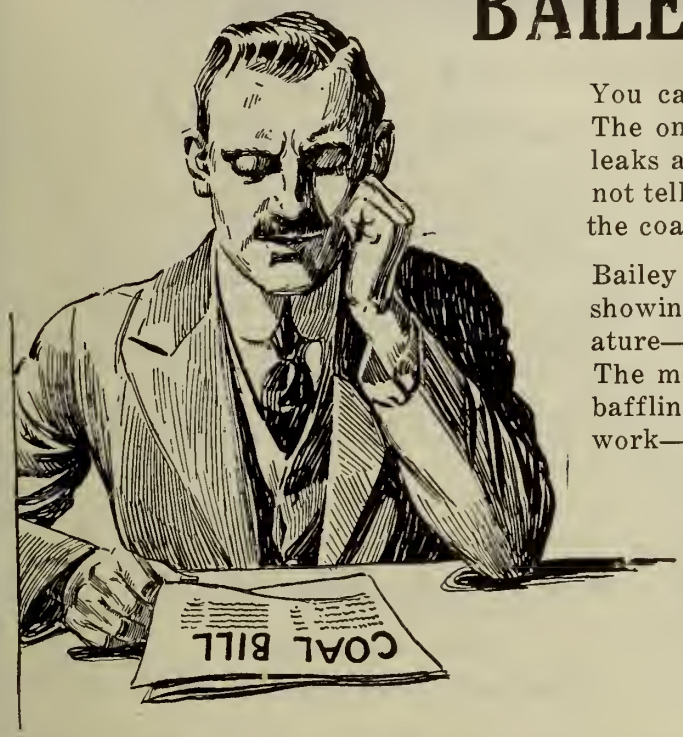

You can't eliminate coal leaks until you locate them. The only way to remove coal bill worries is to find the leaks and **then** go about eliminating them. Instinct will not tell your fireman just how well each boiler is burning the coal fed to it. The best he can do is **guess.**

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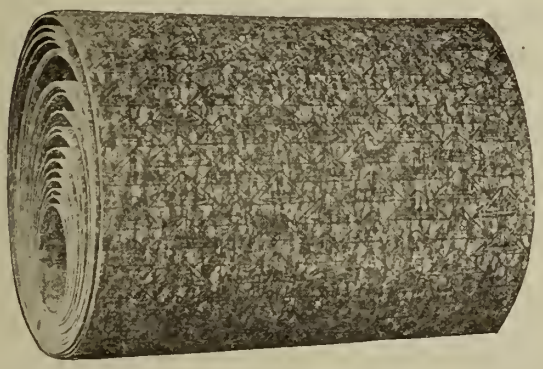

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(Continued next month).

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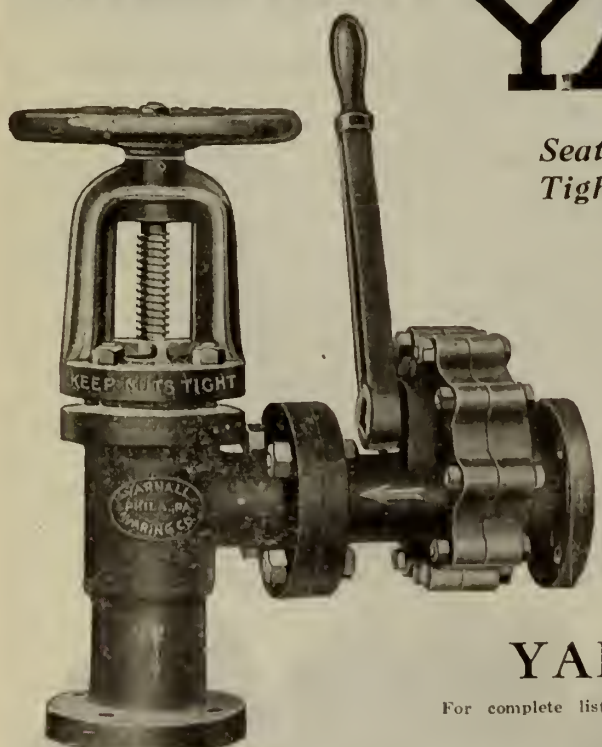

Seatless Blow-off Valve and Double Tightening Valve in Tandem Arrangement

A combination first developed to meet A. S. M. E. boiler code and boiler laws in certain states—that is ideal for blow-off service in any state.

The Yarway Blow-Off Valve is a slow opening, seatless valve that does away with the seat troubles of the old type valves and that automatically tightens the packing after the valve itself has closed, and releases the packing before valve starts to open.

The Yarway Double-Tightening Valve is a quick opening valve with the unique feature of a sealing bushing, (8, above sectional view) on the inlet side which makes the valve double tightening on both sides of the swing gate. With both valves in place the blow-off line is doubly guarded. Highly successful installations of this type are numerous. B-410 is a handy booklet that will show you the unusual features of the Yarway Valves in detail. To whom shall we mail it?

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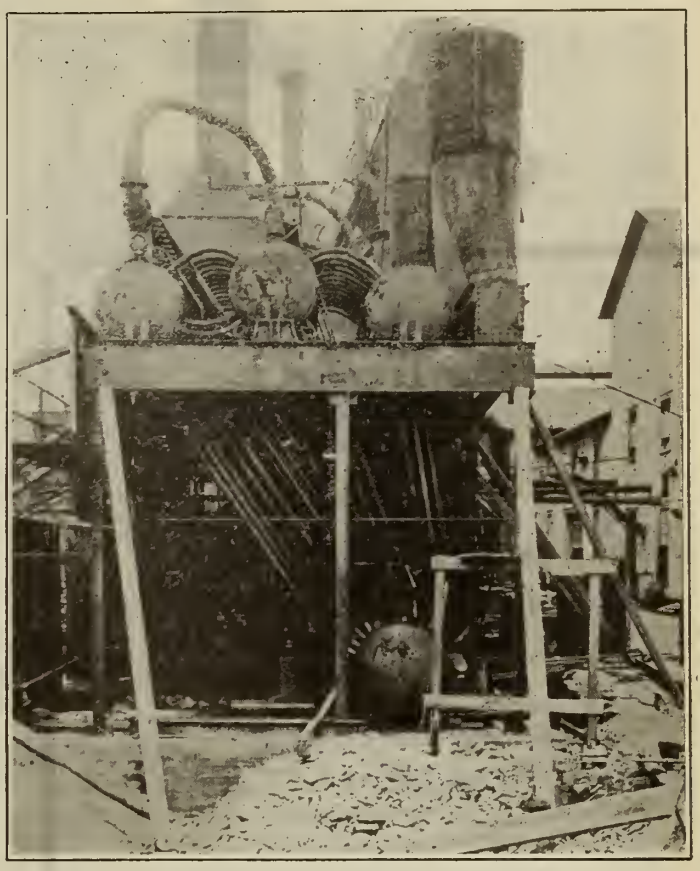
Advantages

The inlet of the saturated steam and the outlet of the superheated steam are located on opposite sides, to insure uniform steam distribution.



Typical installation of Superheater to Sterling type Boiler

THREE ECONOMIES OF SUPERHEAT

Economy is the demand of the hour.

Every expenditure must be a justifiable investment, one that will yield the fullest return.

Nothing you can add to your power plant for more effective power generation will yield a higher return per dollar invested than Elesco Superheaters.

The return from an **ELESCO** superheating investment is three-fold:

A saving of from 10 to 20 per cent. of the coal bill.

An increase in the boiler capacity.

A more efficient boiler which operates at a lower rate when the load is heavy.

You can measure the income on your ELESCO Superheater investment. It is tangible.

Bulletins explain why. Send for them.

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Works: SHERBROOKE, Que.

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Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

(An Independent prime mover at $20.00 per H.P.)

Model FC-4 cylinder 85 H.P. STERLING direct connected to Goulds' centrifugal pump 500G. P.M., 100 lbs. pressure speed 1200 R.P.M.

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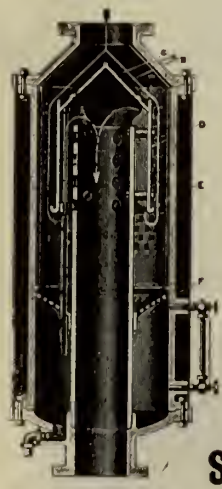
Gas and gasolene Engines 12 to 300 H.P. at speeds up to 1750 R.P.M.

10,000 Sweet's Separators are serving discriminating steam users around the world.



Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

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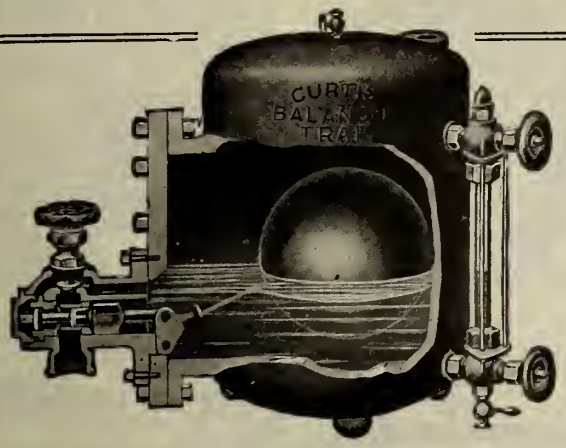

Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1921 Catalog of Curtis Engineering Specialties.
Canadian funds are accepted at par at Montreal.

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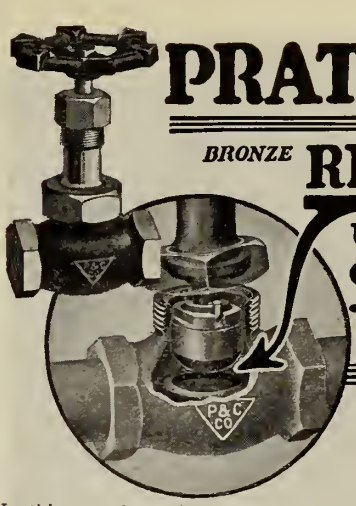

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UNION BONNET GLOBE *and* ANGLE VALVES

Simply insert a piece of wire or a nail through the disc lock nut and stem; then rotate the wheel until a tight joint is formed.

In this way the radial seat disc can be reground many times, requiring no special skill, tools or devices.
This P. and C. Union Bonnet Valve is made especially

For 200 and 300 lb. Pressures

and is of the same high standard as the P. and C. Asbestos Disc Globe and Angle Valves.
It contains many notable improvements—to prevent wire drawing or steam cutting—to make positive steam tight joints—and permitting quick opening and closing of the valve.

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Manufacturers of Valves and Asbestos Packed Cocks that give long and satisfactory service.

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Competent instrument makers, ample equipment for overhauling and testing, indicating, recording and controlling temperature instruments, pyrometers, barometers, etc.

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Taylor Instrument Companies

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There's a Tycos and Taylor Temperature Instrument for Every Purpose
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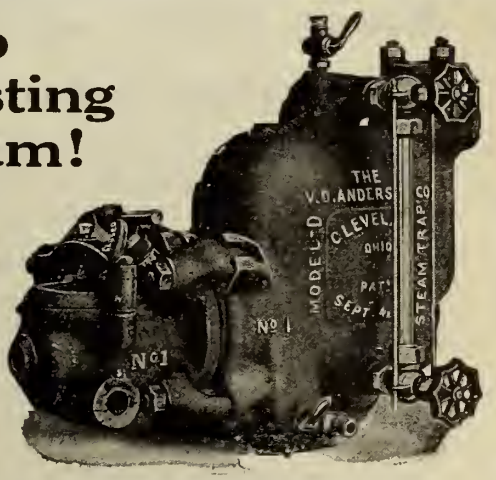
Stop Wasting Steam!



ANDERSON STEAM TRAPS

From the day you install an Anderson Steam Trap you will notice a difference. That difference lies in its absolutely tight action. Never will you find an Anderson that fails to deliver *dry steam* under every condition. It is positive proof against break-downs from accumulated moisture. Our catalog contains a full description of the Anderson—Write for it to-day.

The V. D. ANDERSON Company
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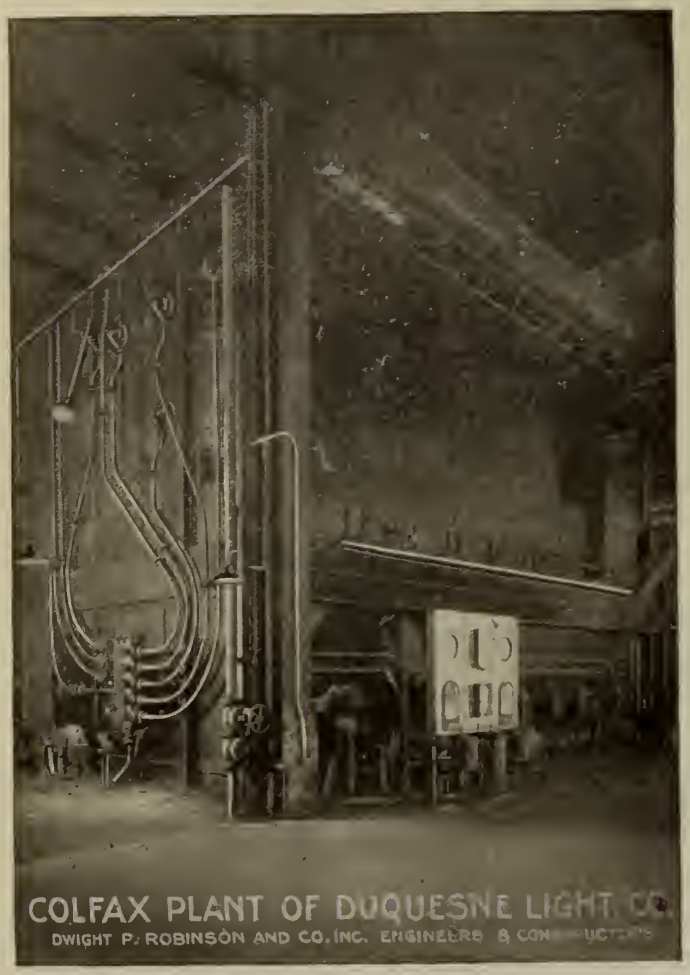

Blowing 20,876 sq. ft. of Heating Surface

It is just as easy and convenient to blow the soot and ashes from the immense heating surface of the Colfax boilers as it would be if your boilers were also equipped with Diamond Soot Blowers. Size of unit, extra width or type of boiler cannot affect the high efficiency and the thoroughness with which the soot is removed.

Clean heating surfaces save coal and increase boiler capacities. That is why the leading central stations and modern industrial plants have found it extremely economical to install Diamond Soot Blowers.

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Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

A Time Clock *and* Recording Thermometer in ONE

The Columbia Recording Thermometer with the new TIME PUNCH does double duty—a two-in-one-instrument. In addition to furnishing an automatic day and night record of every variation of temperature in your heat-treat process, or the regulation of heat for any purpose—it also gives a constant check on the "human element"—shows whether the man responsible for temperature control has been watching the temperature record as he should—whether he has been on the job.

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Knowing that the dial will always tell the tale, both the conscientious and the careless operator are going to toe the mark, thus insuring a more uniform temperature—and avoiding the spoilage and damage which so often result from forgetfulness and neglect when you have no way of keeping tabs.

Columbia Recording Thermometers with Time Punch attachment cost no more than for an ordinary recorder alone.

Simple, direct and positive in their action.

Every instrument rigidly inspected and guaranteed. Any temperature up to 1000° F. can be recorded accurately.

This Time Punch is also furnished on Columbia Recording Gauges and Tachometers.

If you wish to eliminate spoilage, increase efficiency and cut manufacturing costs you should read Columbia Recording Thermometer Catalog H-33. *Write for it today.*

THE Schaeffer & Budenberg MFG. CO.

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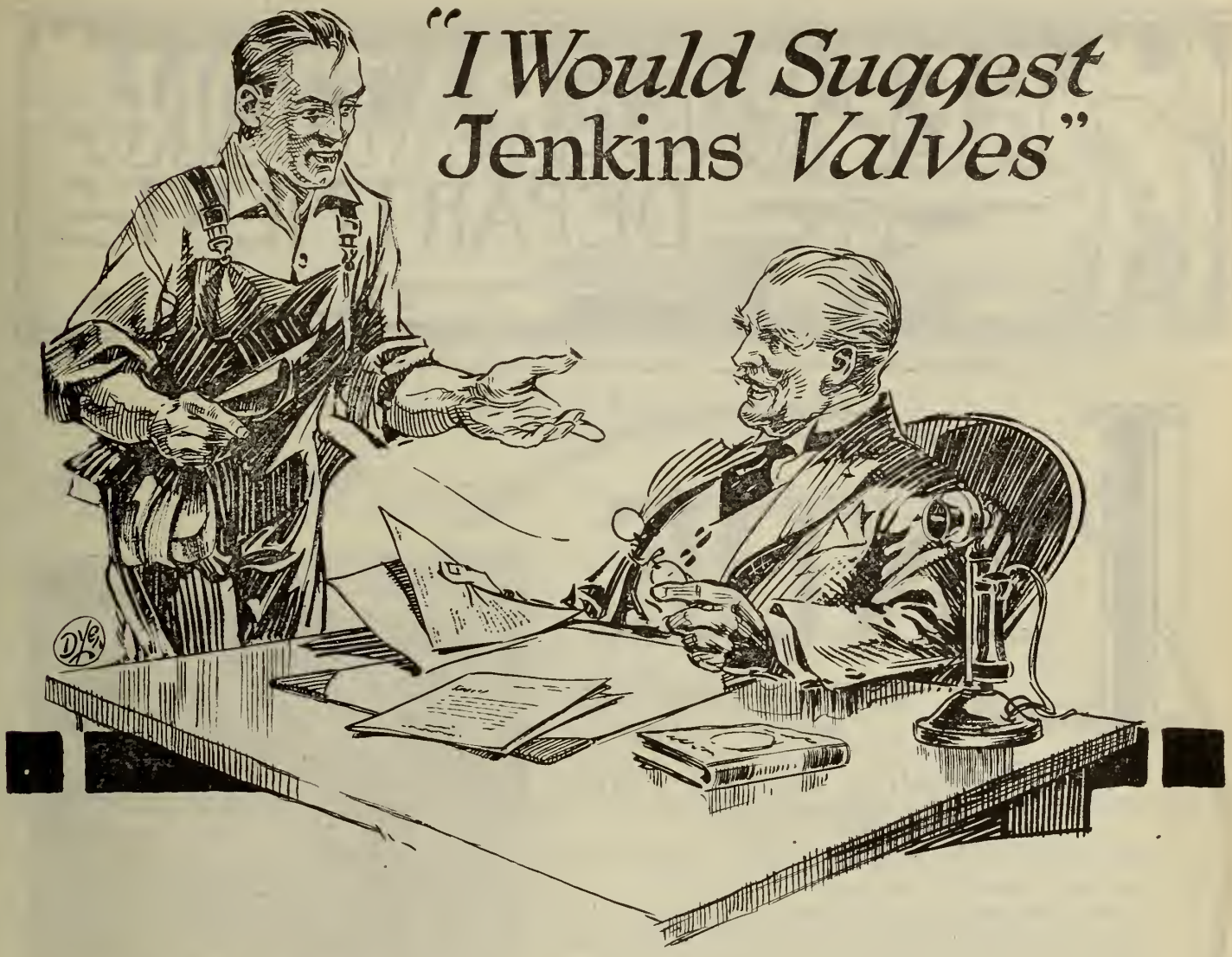
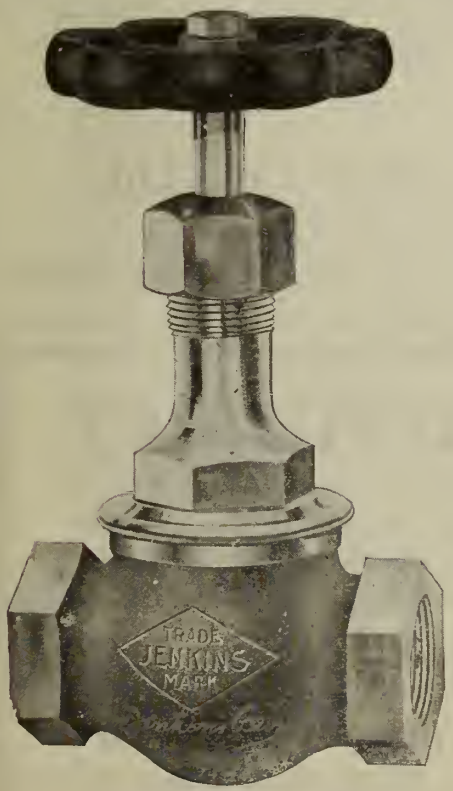
Columbia Recording Thermometers

"I Would Suggest Jenkins Valves"





WHEN the inevitable breakdown—occasioned by inferior valve equipment—occurs, the Engineer who knows valves and valve requirements will invariably suggest Jenkins Diamond-Marked Valves.

Unpleasant reminders do not follow the installation of Jenkins Valves. Made strong and heavy and made of the best brass, iron or cast steel, they remain dependable and unaffected when subjected to the strain of hard usage and severe service.

Jenkins Diamond-Marked Valves are made in a size and a style to completely control the passage of steam, water, air, gas and other liquids or vapors.

Obtainable at supply houses everywhere.
Catalog No. 8, describing the entire line, free on request.

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Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

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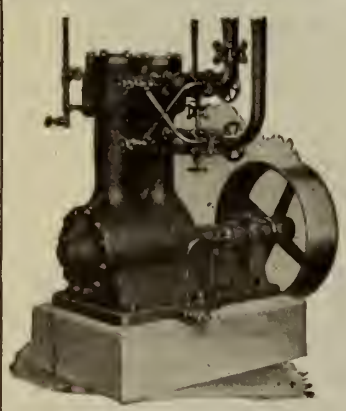

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Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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Our Machines are in daily operation in Canada

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ICE MACHINERY SUPERIOR SINCE 1882
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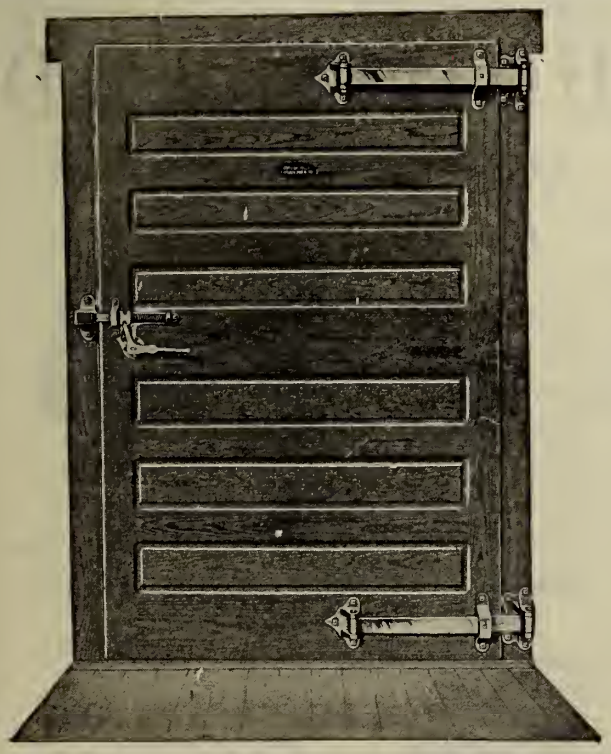
There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



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"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

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Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

In this hardening room of the Detroit Creamery Company, Detroit, Mich., the Nonpareil Corkboard Insulation of walls, floor and ceiling is 8 inches thick.

Insulation Saves Refrigeration

Except in very well insulated rooms, far more refrigeration is used to carry off the heat that leaks in through walls, floors and ceilings than to cool and keep the goods stored. The more this inflow of heat can be reduced by adequate insulation, the less refrigeration will be required.

The recognition of this fact is evidenced by the increasing tendency of refrigerating engineers and operators to use Nonpareil Corkboard Insulation in greater thickness than formerly. In many modern plants, operating economies have been found to justify fully the insulation of hardening rooms and sharp freezers with 7 inches or 8 inches of Nonpareil Corkboard. Increasing the thickness, and consequently the efficiency, of the insulation does not proportionately increase its cost. No more labor or materials, other than the corkboard are required to install 2 layers of 4-inch than for 2 layers of 3-inch. The remarkable ability of Nonpareil Corkboard to resist moisture and hence to retain indefinitely its initial heat retarding value spreads the investment over a very long period.

Its insulating efficiency, structural strength and durability have established Nonpareil Corkboard as the most economical insulation. To secure its maximum value, see that the thickness is adapted to your peculiar conditions of temperature, exposure and refrigeration cost.

The Company's engineers will gladly co-operate with you in working out the most economical thickness for your particular conditions. There is no charge for this service. Much valuable information on insulating cold storage rooms will be found in the 152-page book, "Nonpareil Corkboard Insulation," which will be sent free on request.

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In this hardening room of the Detroit Creamery Company, Detroit, Mich., the Nonpareil Corkboard Insulation of walls, floor and ceiling is 8 inches thick.

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FOR COLD STORAGE ROOMS

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A valve to be economical must give dependable, lasting service.

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Elimination of waste time and leakages quickly pays for all Homestead valves. You would do well to adopt them without delay.

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The machine occupies a comparatively small floor space.

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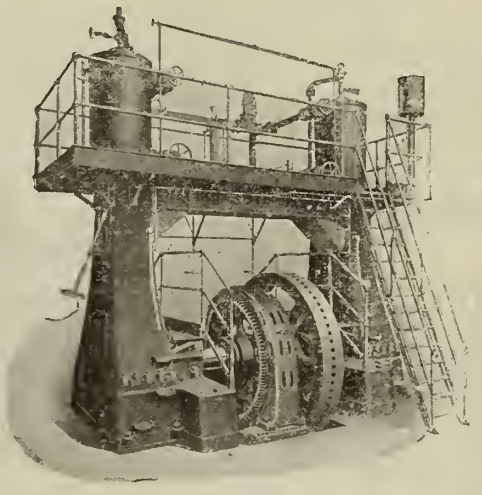
These machines are built in sizes from 30 tons refrigerating capacity upwards.



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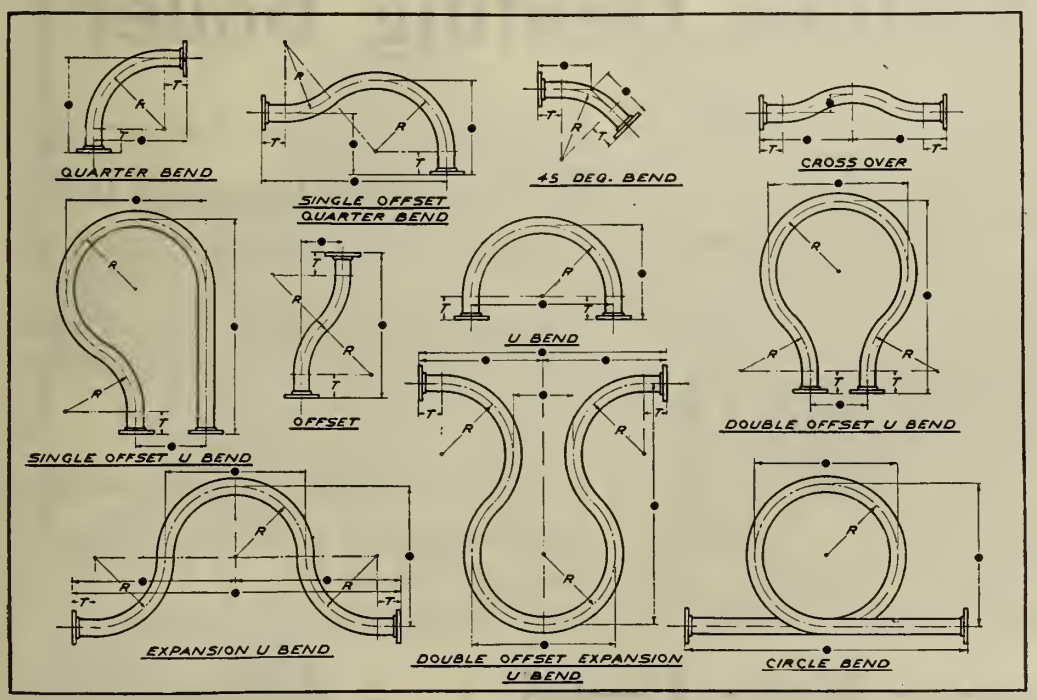

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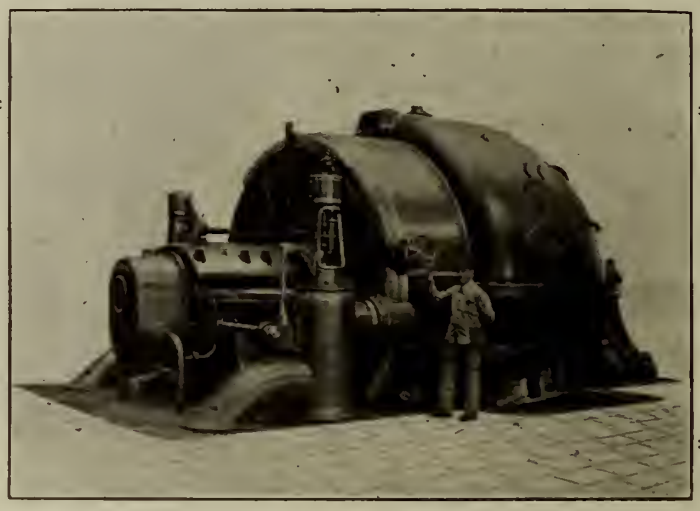
Zoelly Steam Turbine



Zoelly Rotary Compressors

Agents for British Columbia

12,000 K.W. Zoelly Turbine

THE ENGINEERING CORPORATION, Limited, 903-906 Rogers Building, Vancouver

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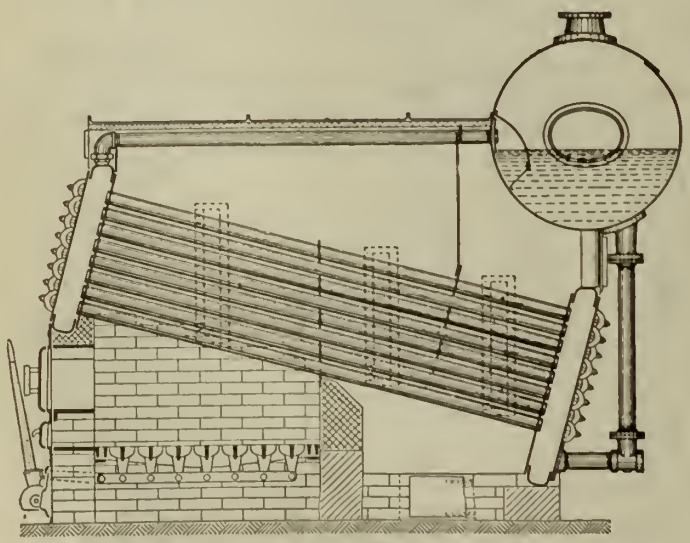
The Victory Heating Boiler



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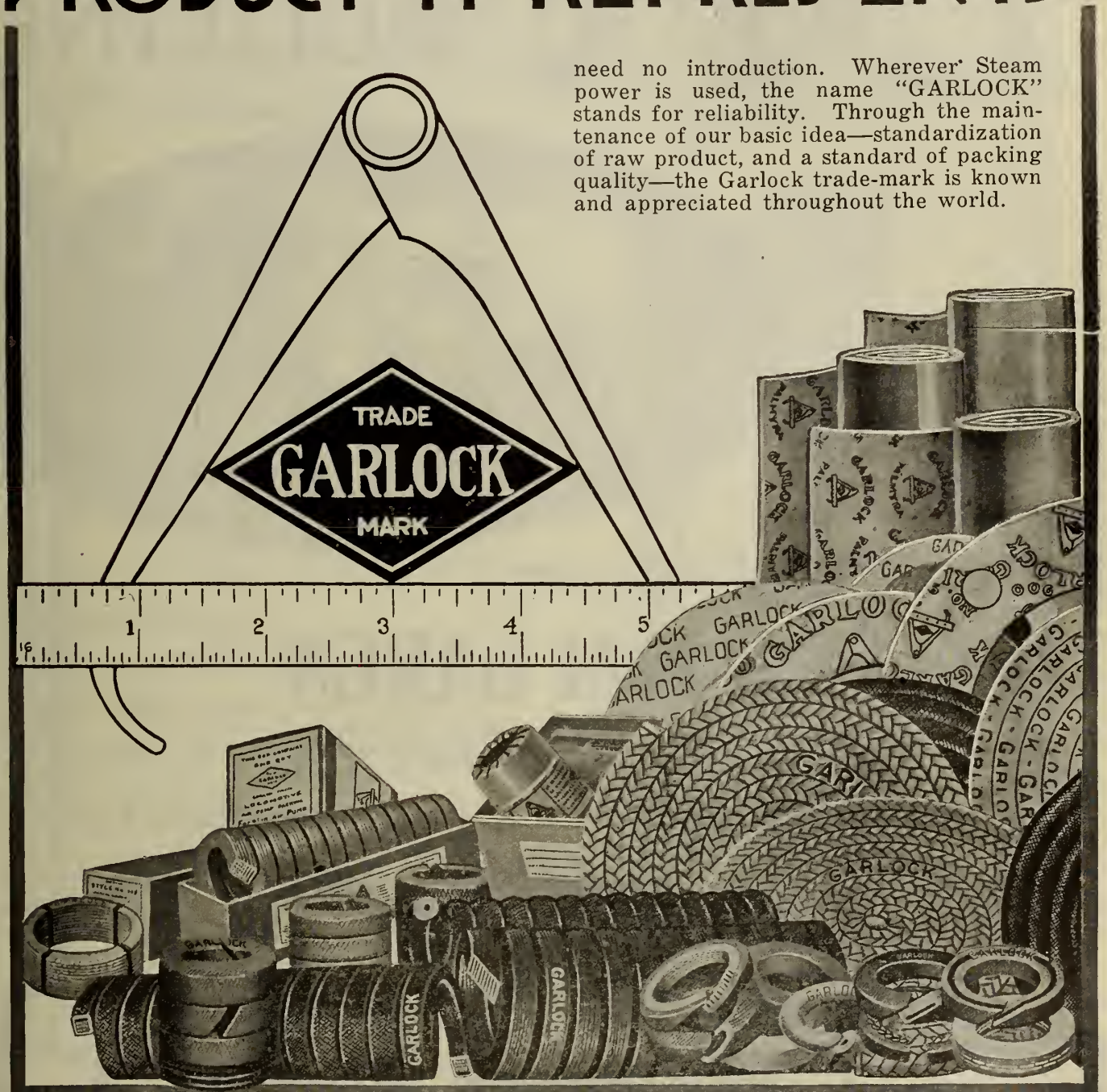

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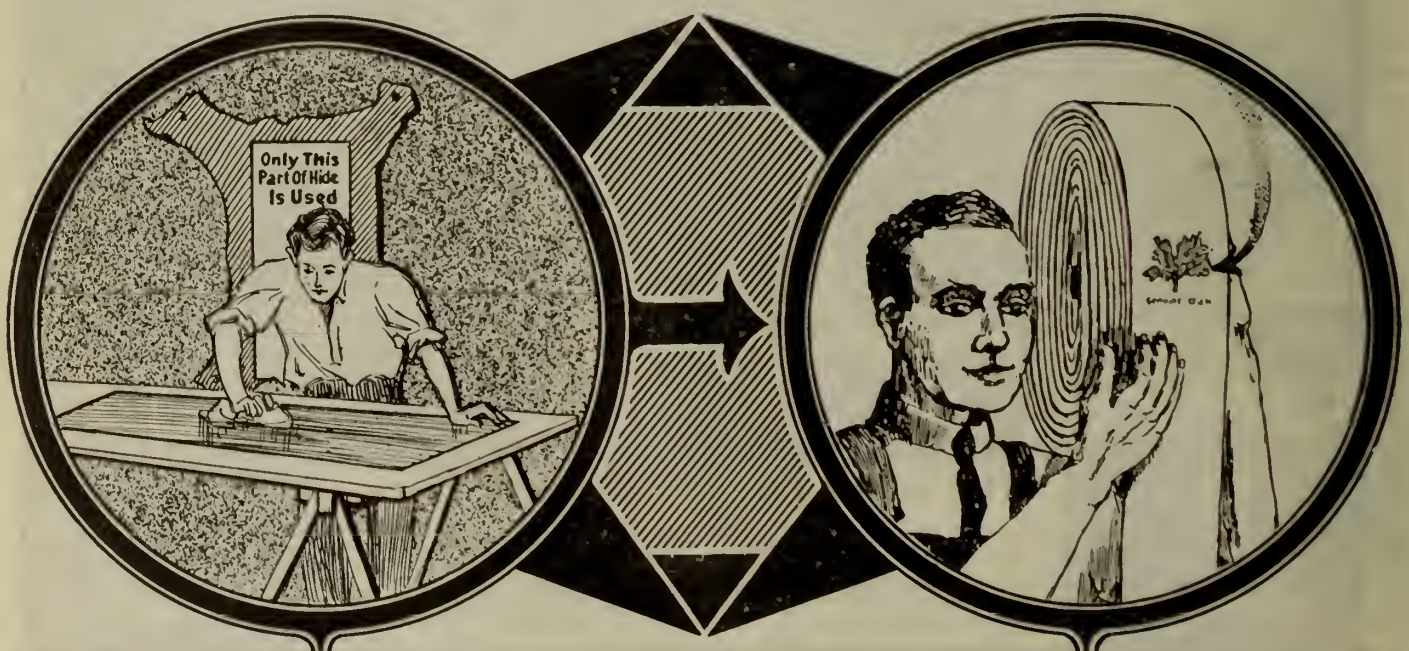

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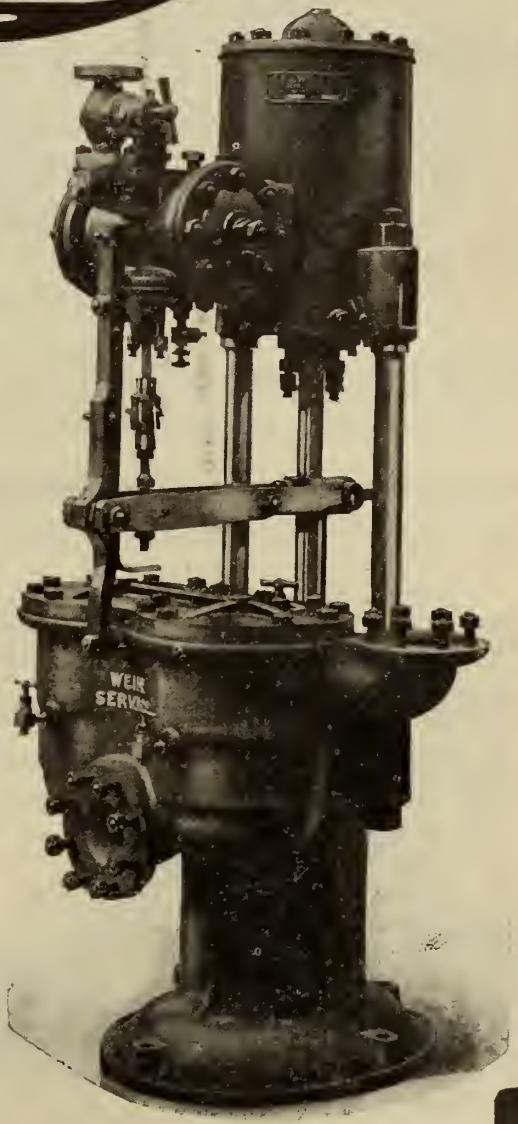
Every Part Built to Standard Means Uniform Service

There are three big reasons why a pump might fail to give satisfaction. Either it is not built right, it is the wrong type for the job or else the manufacturer fails to supply it with proper adjustments.

Weir Methods of manufacture eliminate all three of these possibilities. Weir pumps are built right; (65,000 users all over the world will tell you that). Weir Engineers analyse your requirements carefully and supply the pumps that fit. Weir method of standardizing all parts is the customer's guarantee that any new part will fit as perfectly as the old one.

In addition to a complete line of Pumps Weir products include Multiflow Heaters, Direct Contact Heaters, Evaporators and Distillers. Write for literature.



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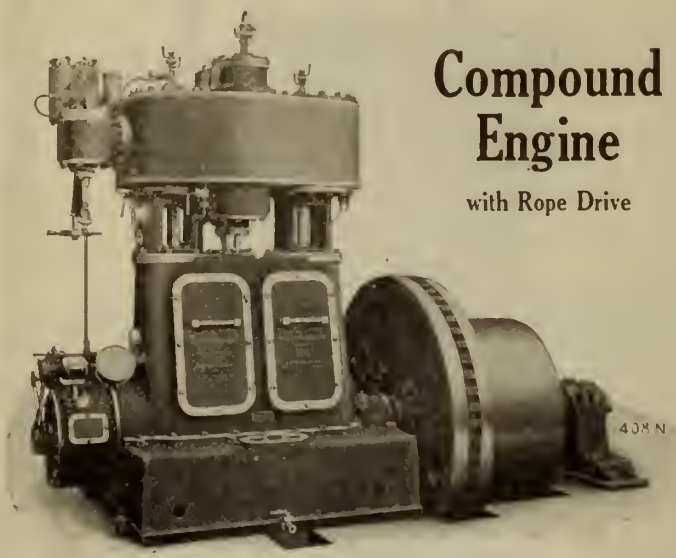

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with Rope Drive

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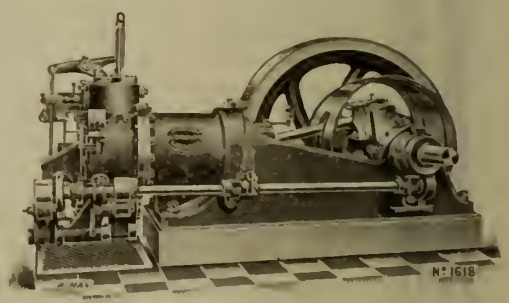

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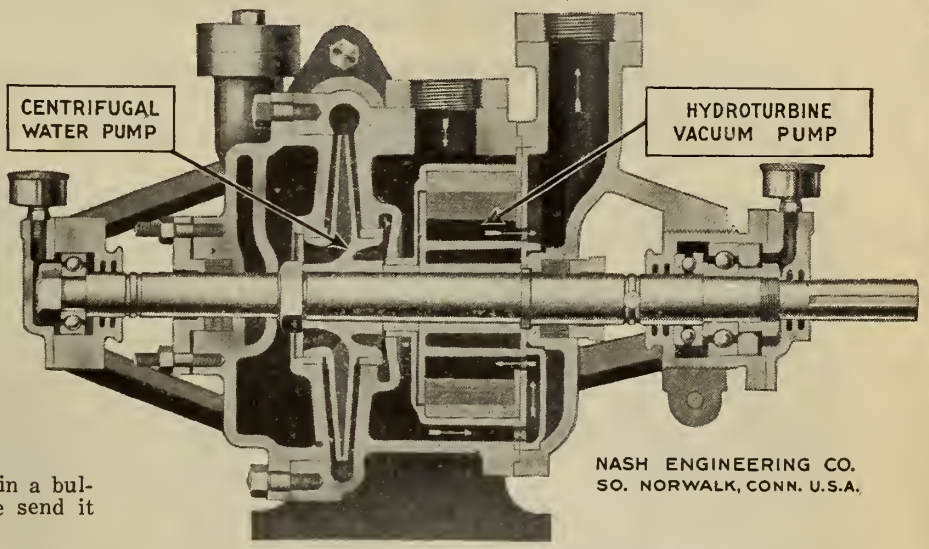

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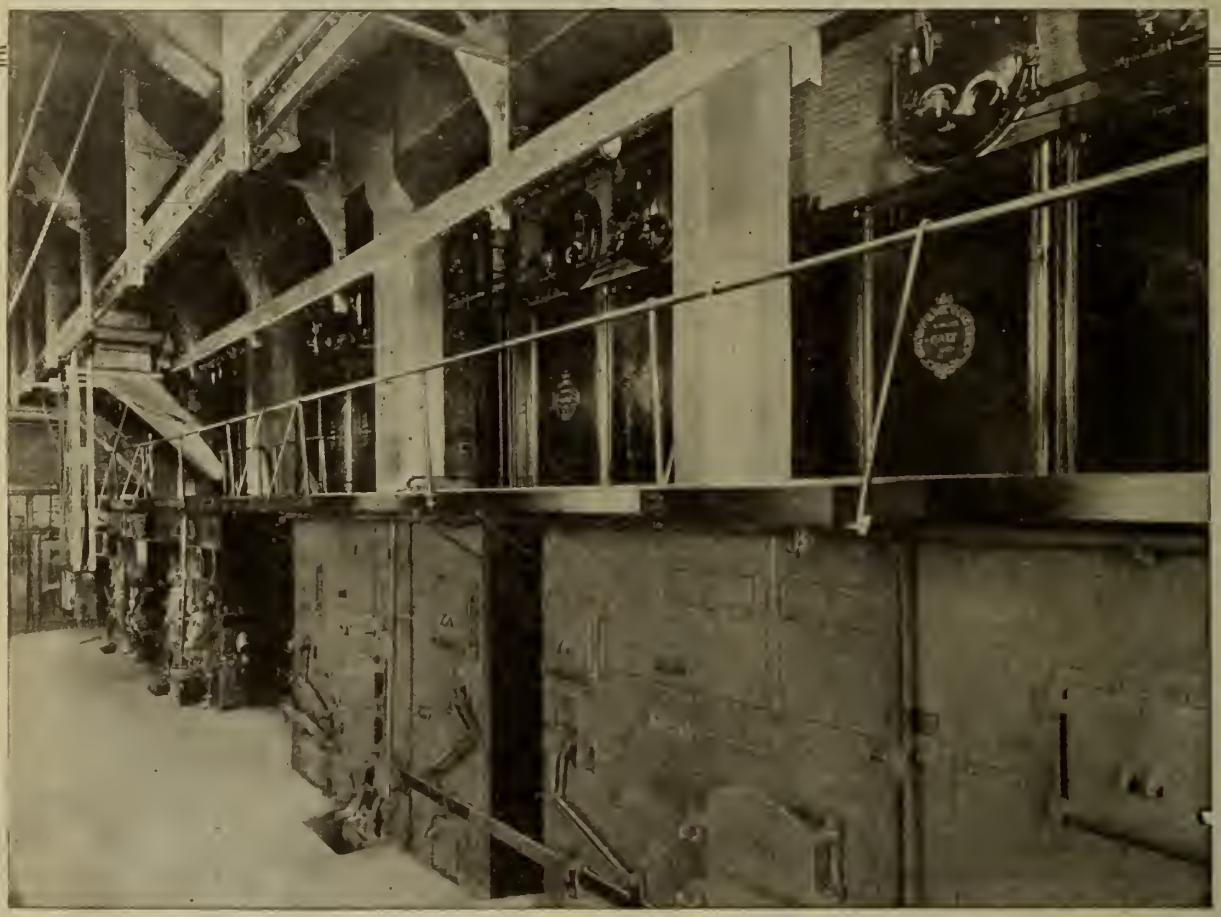

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A Great C. A. S. E. Convention in Ottawa

The Convention from Every Point of View Was a Great Success —A Large Number of Exhibitors Were on Hand, and the Entertaining Was Well Taken Care Of

THE MONTH of June is noted for leafy trees, June brides, and the C. A. S. E. Convention, and the month just passed was no exception in any of these features, We don't know if there were any more leaves than usual, or any more brides, but we do know that the Convention was one that has to be described in superlatives. In spite of the weather man, who did his best to sap the energy of all those in attendance by turning on an extra dose of heat and humidity, interest never laxed from the time the convention was declared open till the last function took place on Thursday, and every event on the programme was carried off in great style, with lots of enthusiasm.

The convention headquarters were at St. Patrick's Hall, Laurier Avenue, right opposite the recreation grounds, and close to the Armory. The hall is situated only about five minutes walk from the station and the principal hotels, and was very well chosen for the purpose. The exhibition of power plant supplies was placed in the main hall, while the delegates to the Grand Lodge C. A. S. E. held their deliberations in a suitable room upstairs.

The Opening Day

The opening day, Tuesday, June 28th showed a scene of great activity in the Hall, where the finishing touches were being put to the exhibition by the various representatives of the firms occupying space. The booths were much further ahead than is usual at this stage of the proceedings, and there is no doubt that a great deal of work had been put in on the previous day to have everything ready for the opening.

The Grand Lodge went into session at 10 A. M. prompt, and remained in the meeting until 11 A. M. when they came down to meet the exhibitors and to perform the opening ceremonies. The chair was taken promtly at 11 A. M. by Mr. Leach, President of the Grand Lodge, and on the platform with him were Mr. Earl Hethrington, of Goldie McCulloch & Co, chairman of the Exhibitors Association Entertainment Committee, Mr. C. B. Turner, Chairman of the Exhibitors Association, Mayor Plant of Ottawa, and the secretary of the Ottawa Lodge. This gentleman introduced Mayor Plant to the delegates, visitors and exhibitors in a few words, which were however fully appreciative of his worship. Mayor Plant then formally welcomed the convention to Ottawa, and gave them to understand that the city was theirs. He dwelt with pardonable civic pride on the many attractions which the capital boasts, and then went on to mention those of the little industrial city across the way, which as is well known, has some special features of its own. The worthy Mayor, who is evidently not one of those who voted dry, spoke with appreciation of the comfort to be extracted from a visit to Hull, and then with great thoughtfulness, told the gathering that he had given the police instructions to the effect that anyone wearing the badge of a visitor, delegate, or exhibitor, at the convention, was to be immune from any interference, even if their behavior should be strange. We are glad to say that the safe conduct thus kindly furnished by the Mayor did not have to be used, those who patronised the trip to Hull being evidently well fortified and able to stand it without any signs of wear. This of course was to be expected of the delegates from Montreal, but it was a very creditable showing for those who came from regions that have been more or less dry for some considerable time, and thus without the opportunity for steady training.

The Mayor was loudly cheered at the conclusion of his speech of welcome, the audience rising en masse and singing "He's a Jolly Good Fellow" and singing it with real heartiness. Short speeches followed from Mr. Leach and Mr. C. B. Turner, the latter calling attention to the excellence of the exhibition which he said considered as a purely power plant proposition, was the biggest thing in Canada. A few words from Mr. Hethrington concluded the opening ceremonies, and the convention was away to a good start.

iness session of the engineers, and at 4

The afternoon was devoted to a business session of the engineers, and at 4-P. M. a visit was paid to the exhibitions. During the afternoon the Deputy Minister of Public Works in the Federal Government together with some of his staff paid a visit to the Hall, and was much interested in the various appliances and apparatus that were on view. There was much to interest any one who came, and it is pleasing to note that quite a few outsiders availed themselves of the opportunity as well as the engineers and their friends.

The evening was given up to a trip out to Aylmer, the drive being very welcome after the torrid heat of the day. There is no doubt that Ottawa deserves its reputation of being the hottest in summer and the coldest in winter of all Ontario's cities, and the long run out in the beautiful country surrounding the city was much appreciated. Some of the more energetic staged a little dance when they arrived at the Park, but for the most part the visitors were glad to stroll around and enjoy the cooling breezes, and gain strength for the coming day.

TheExhibition

Before going any further it would be well to pause and give some time to the exhibit, which was pretty unanimously termed the best ever. That verdict was well deserved, and the trouble gone too by some of the exhibitors to make a good showing deserves a great deal of credit. There is no person outside of those actually engaged in the work, quite realises how much trouble and expense are incurred in these exhibitions, or how many months of preparation are needed to make them a success. However we think that on this occasion the efforts of the exhibitors were well appreciated, and more attention given to the booths and their contents than on some other occasions. It was a liberal education for any engineer to stroll around that Hall, and see the number of things that have been developed and perfected for the better operation of the plant that he has charge of.

The following firms were represented by exhibits in the Hall:—

..Crane Ltd. Montreal, showing a full line of valves, fittings, and steam traps. A large pipe bend was a feature of this exhibit.

The Underfeed Stoker Co.. Toronto, showing a model of their underfeed stoker and a working model of the cole stoker regulator.

Darling Bros., Montreal, showing a full line of heating specialties.

The Garlock Packing Co., Palmyra, N. Y. with a full line of high and low pressure, steam and hydraulic packings.

Beveridge Supply Co., Montreal, special refractory cements.

Ogilvie Bros., Montreal, Patent high andlow water alarm, aperated on an electrical system without the use of any floats or wdrking parts.

W. R. Secton Boiler Setting Co., Toronto, showing Nonpareil fire grates etc.

The V. D. Anderson Co., Cleveland, showing steam trap.

The Dunlop Tire and Rubber Co., rubber goods.

The Imperial Oil Co., Toronto.

Babcock and Wilcox. Watertube Boilers, mountings etc.

Canadian Allis Chalmers, Toronto.

Instruments Ltd., Ottawa, showing a very complete line of heat measuring instruments, electrical CO2 recorder, pyrometers,etc.

Power House, Toronto.

Canadian Manufacture, Toronto.

Power, New York.

C. B. Turner & Co., Toronto, showing a number of samples of scale etc, taken from boilers by his process.

Dominion Flow Meter Co., Toronto, showing steam flow meters, etc.

France Packing Co., Philadelphia. Patent metallic packing.

Dearborn Chemical Co., Toronto.

George W. Cole Ltd., Toronto, showing Cole traps and Monash valves.

J. A. Langelier, Ottawa, showing Lunkenheimer valves.

Dart Unions Ltd., showing union joints.

Westco Pump, Toronto, showing motor driven centrifugal pump.

Quaker City Rubber Co., Philadelphia, showing P. P. P. packing.

Jenkins Bros. Ltd , Montreal, showing a full line of valves.

James Morrison Brass Mfg. Co., Toronto. Steam Gauges, reducing valves, injectors and valves of all kinds in brass.

The Second Day

The morning of Wednesday opened with ominous clouds, but just as much heat. The forenoon was devoted to a business session of the Grand Lodge, and a further visit to the exhibits. The afternoon had been set apart for a motor drive around the cty, followed by the annual sports at Lansdowne Park. However, this programme did not seem to suit the weather man, who sent along a severe thunder and rain storm, and effectually cancelled the proposed drive. Not to be daunted however, the entertainment committee of the Exhibitors Association arranged for the use of Howick Hall for the sports, and they were held accordingly. In spite of the heat, which was no less following the rain storm, all the events were run off, and a very meritorious performance put up by the various contestants.

The following events were run off:—

100 yards dash:—Won by J. Thompson, Toronto.

Thread and Needle Race:— Won by Mrs R. C. Leach, Toronto.

Donkey Race:— Won by Grant. E. Cole, Toronto and W. E. Fyfe, Montreal.

Married Ladies, Race:— Mrs Edge.

Backward Running Race:— George F. Galloway.

Ladies' Clothes Pin Race:— Muriel Berry.

Men's Smoking Race:— G. F. Holloway.

Charm Race:— Mrs Edge.

Wheel Barrow Race:— Grant E. Cole and W. E. Fyfe.

Little Boys' Race:—Charlie Clark.

Little Girls' Race—Olive Berry.

The ball game was won by the Exhibitors by one run.

The starter was of course George Moll of London without whom we doubt if the sports could go on. Messrs Lyon and Keith acted as judges and Mr. Hethrington as Director.

The Evening Concert

The evening concert which followed the afternoon's strenuous excitement, was a real delight to all those who braved the heat of the Hall to hear it. Expressions of surprise were heard from several who have not had the opportunity of being present at one of these entertainments, at the excellence of the talent which was revealed. Most of the old favorities were present, including Mr. Curzon of Montreal, Bob Jones, of Philadelphia, Mr. Jack Armour, the ever popular Jack, whose public entertainments are only surpassed by those he gives to the privileged few, and Earl Hethrington, whose tenor is as pleasing as ever. Besides these, four little pupils of Miss Dunlop of Ottawa, put on a Scottish dancing turn which brought down the house. There were two little boys and two little girls, and to the skirl of the pipes, they went through a long dance and encore in all their heavy Highland accoutrements, with vim and dash, when most of the audience were hot just looking at them. They received a great hand when they finished, and repeated their performance in the second half of the programme.

After the concert was over, the prize drawing was held, and this furnished as much amusement and pleasure as it always does. The lucky man to receive the handsome meerschaum pipe donated by Mr. C. B. Turner was George Nicholson. Ottawa.

After everything else was done, some of the more intrepid spirits started a little dance, and kept it up for an hour or so, not being willing to leave anything undone that could possibly be done. We understand some of the boys didn't even conclude with the dance, but this being only hearsay, we will not dwell on it. Knowing some of them as we do, we are inclined to think that there may have been something in it at that.

Get Away Day

All good things have an end, so with the coming of Thursday morning preparations for departure were very much in evidence. The engineers ascended to their upper chamber to carry on the election of Grand Lodge officers for the ensuing year, and to decide on a place for next years Convention. While the engineers were thus busy, the Exhibitor's Committee held a meeting to elect their officers for the coming year also.

The following gentlemen were elected to office in the Exhibitor's Association:—

Past President:— C. B. Turner, Toronto.

President:— Grant Cole, Toronto.

1st Vice President:— E. B. Curzon, Montreal.

2nd Vice President:— J. Thompson, Toronto.

Treasurer:— Lloyd E. Archibald, Toronto.

Ass. Sec. :— Bob Jones, Philadelphia.

Chairman Entertainment Committee:— Earl Hethrington.

Chairman Exhibitor's Committee:— R. A. Lyons, Toronto.

It was voted that a letter of thanks be forwarded to Bob Jones, E. B. Curzon. Jack Armour. Mr.Marchand. Mr. Dickson for their services to the entertainment. A standing vote of thanks was also given to Mr. C. B. Turner the retiring president for the efforts he had put forth to make a success of the exhibition. Mr. Lyons made some suggestions along the line of getting a still bigger exhibition for next year. The meeting concluded with a song from Bob Jones, and expressions of satisfaction over the success of the convention.

The Grand Lodge officers of the C. A. S. E. for the coming year are as follows:—

President Bro F. Harper. Kingston
Vice President H. Wright, Montreal.
Sec. Treas. L. J. Ellis, Hamilton.
Cond. G. W. Galloway, London.
Doorkeeper R. Rodney, Ottawa.

It was decided that Kitchener should be the convention town next year, that go ahead community having extended a very hearty invitation to the Grand Lodge to come there.

So ended a convention that looked at from any angle was a source of satisfaction to those participating. The delegates and visitors had the opportunity of seeing a first class exhibition of power plant appliances, and the exhibitors had the satisfaction of knowing that their exhibits were viewed with interest, and though direct results are not looked for, some of them received even this. Next year's convention at Kitchener will be, if the efforts of those concerned can so make it, even better than this one, and we hope it will see a bigger, stronger and ever growing C. A. S. E.

A Description of the Bettington Boiler

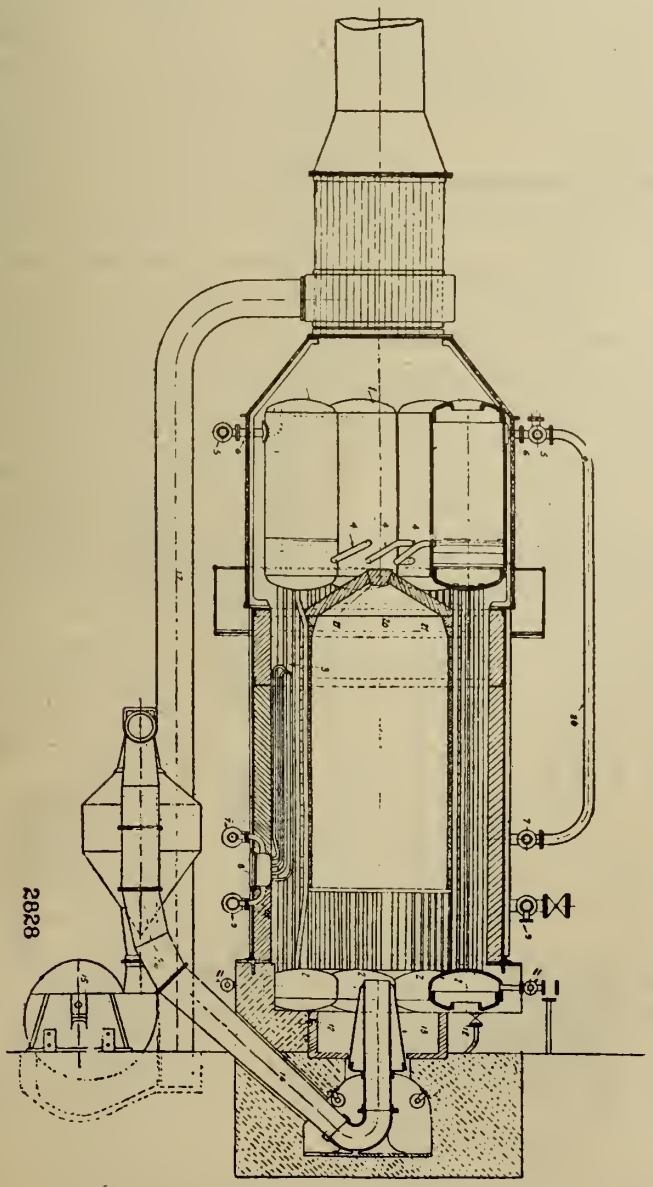
This boiler has been designed to burn pulverized coal, oil, or gas, and other atomized combustibles. For this description we are Indebted to "The Engineer," London.

THE Bettington water-tube boiler is designed to use pulverised coal, oil, gas and other atomised combustible substances. Introduced originally before the war, the boiler, though it had passed the experimental stage and was giving satisfactory results on a commercial scale, did not satisfy the makers on all points, and investigations were in hand to improve the design when war broke out and put an end to further research on the subject.

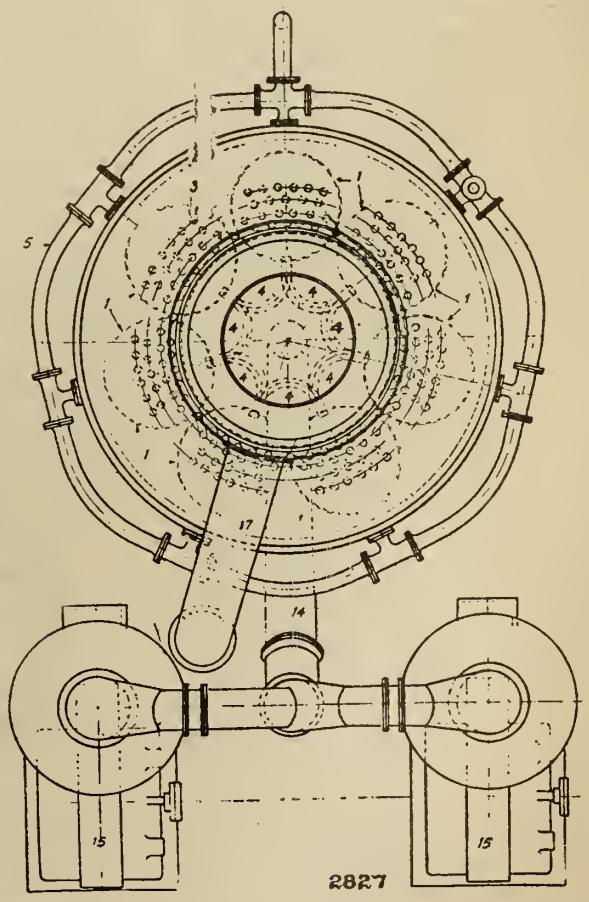
Opportunity has since been given to continue the investigation, and the makers (Fraser and Chalmers Engineering Works of the General Electric Company) have now brought out a new design, embodying the same principles, but altered in certain points to give greater strength and reliability.

A section of the boiler is shown in Fig. 1. The cycle of operations is as follows: Coal is fed from a hopper into the pulveriser, which consists of a rotor, fitted with manganese, steel beaters on the periphery. The pulveriser also acts as a blower, and, after the coal has been disintegrated, it is delivered into the dust separating chamber, the fines passing direct to the fuel nozzle, the coarse particles returning by gravity to the pulveriser for further reduction. The air with which the pulverised fuel is mixed is pre-heated from the exhaust gases. The combustible mixture enters the furnace vertically along its central axis, and immediately passes into a high temperature zone. The momentum of the coal particles carries them upward in company with the central current of the hotter gases, when the most intense reaction occurs. The action of gravity ultimately overcomes the upward momentum of the coal particles and such of them as are not already completely consumed "mushroom" over, coming in contact with the relatively cooler brickwork and tubes forming the retaining walls of the furnace. By this time combustion is virtually complete, and the burnt out gases provide an enveloping sheath to the zone of most intense reaction, thus actually forming an indestructible lining of gas between the intense zones and the furnace wall.

The course of the burning particles of coal is such that they are constantly changing to a fresh supply of oxygen without any tendency to concentrate in more or less horizontal stream lines, as is the case when the momentum and gravity act at right angles to one another. The ash of the fuel in its passage through the zone of highest temperature is converted into a liquid spray. A portion of this liquid ash strikes the brick lining of the furnace, and, in time, trickles down to the bottom edge, being



SECTION ELEVATION



PLAN OF BOILER

kept in a molten state by the descending hot gases, till it finally reaches the lower or "dripping" edge of the furnace proper. Being unable to adhere to the water-cooled surfaces, it drips and falls clear to the ashpit, which, being relatively cool chills it sufficiently to prevent the succeeding drop from adhering to it.

The boiler itself consists of mild steel top and bottom headers, with solid-drawn steel tubes connecting them. A top and a bottom header with their connecting tubes form a distinct unit which can be removed and replaced without disturbing the other tubes and headers. Special bricks in combination with the innermost circle of tubes, form the wall of the combustion chamber, the water tubes preserving the bricks from melting by conduction and evaporation. A feature of the design is that it is possible to dispense with fireclay in the building of this brickwork, for the liquid spray formed by the ash of the burning coal forms, when it comes in contact with the furnace walls, a slag which hermetically seals all crevices and cements the lining into one solid piece, as well as glazing the inner surface as though with a smooth enamel.

The super-heater consists of vertical tubes running parallel to the main boiler tubes. As will be seen from the drawings, a sectional design has been adopted for the super-heater to allow of the speedy withdrawal and replacement of any damaged section. Owing to the complete combustion and the forced draught, only a small smokestack is required. The gases before entering the stack pass through an air-heater, and thereby give up some of their heat to the air, which is drawn through the pulverising fan and forced into the boiler with the fuel. This pre-heating of the air allows of the use of coals containing up to 15 per cent. of moisture. Slides are provided in the pulverising fan for regulating the amount of air, and the coal feed is operated by means of a variable speed friction wheel driven from the shaft and controlled by an adjustable slide in the hopper.

The method usually employed for driving the pulverising fan is by direct connection through a flexible coupling and motor, although steam engines and small turbines have been substituted in some cases with satisfactory results. To fire up the boiler when cold a lighted torch is placed above the fuel nozzle, the pulveriser started and the fuel feed turned on. After the fuel mixture has ignited, the torch is extinguished and the fuel feed set to the desired rate. After temporary stoppages it is sufficient to start the pulveriser and turn on the fuel feed when ignition takes place from the hot brickwork.

Among the advantages of the boiler, it is claimed that the amount of scale deposit is very much less than occurs in other types of boilers with more sluggish circulation and with horizontal water tubes in which the scale tends to settle on the lower side and form patches. The rapid circulation in the Bettington boiler ejects loose scale to the bottom headers, where it can do no harm, and is in due course blown out. Another advantage of the vertical tubes is that soot and dust do not accumulate on them and so cause a loss in heating efficiency. It is further claimed that, owing to the symmetrical construction and concentric method of fixing these boilers, all differential expansion strains are eliminated and no abnormal stresses set up when firing a cold boiler at maximum rate.

Two of these boilers are now being installed in the Fraser and Chalmers Engineering Works at Erith for electric power supply, and arrangements have been made in the shops to meet outside orders.

No figures are at present available of the performance on a full scale of the improved Bettington boiler, but it is hoped to have these figures as soon as the installation at Erith is completed. As allowance has been made in the new design for higher working steam pressures and greater efficiency in the superheater, combined with a higher reliability and safety factor than existed in the pre-war model, it is expected that a substantial increase in thermal efficiency will be shown.

PROPER CONNECTIONS FOR SHUNT-FIELD RHEOSTAT.

M. M. Beach.

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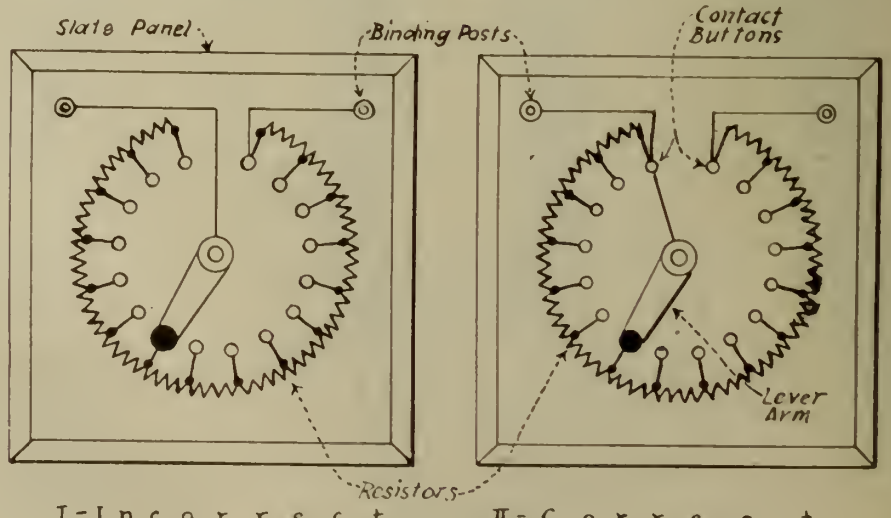
Difficulty may be experienced due to the fact that the lever arm on a shunt-field motor rheostat does not always effect good connection with the contact buttons. This may result in the opening of the shunt field circuit. Then, the motor will operate at abnormally high speed. In some instances such a trouble can be corrected by making a change in the connections. The general principle involved is illustrated in Fig. 1. If the connections are made as shown at II, the field circuit can never be open in the rheostat—even if the lever arm makes poor contact with one of the buttons. At 1, the incorrect method of connection, whereby the field circuit is open if the button contact is poor, is diagrammatically indicated.

A PORTABLE PETROL DRIVEN CRANE

Steam and electricity have hitherto been the chief means of driving cranes of a size larger than could be operated by hand, but the compactness and the convenience of the petrol engine have led recently to its application to cranes of the lighter grades. A good example of this new type is a portable crane developed by a British firm mainly for use in building operations. It is driven by a two-cylinder petrol engine and is made in two sizes, one capable of lifting half a ton and the other with a capacity of one ton. An important feature of this crane is the special gear which enables the driver, simply by moving a control handle, to lift a load at any speed from a crawl to the maximum, while the engine runs continuously at its most efficient speed. If for any reason the handle is released the brake is automatically applied on the instant and the crane comes to rest with the load suspended. The engine acts as a counterweight and the whole equipment is so light and well-balanced that it can be easily moved about on its four wheels or slewed as desired.

SUCCESSFUL BRITISH TRACTORS

The merits of the British-made tractor for agricultural purposes were conclusively demonstrated during a trial on a rubber estate in the Far East. All conditions were against success. The soil consisted of heavy sand or of sand mixed with clay, and rain had fallen heavily prior to the trial. Nevertheless the driver was able to turn and manoeuvre with the greatest ease. Further, the tractor showed its hauling powers by pulling two large trucks, weighing about 11 tons up the hill.



CORRECT AND INCORRECT METHOD OF CONNECTING RHEOSTAT

Recording Ash Pit Loss from Chain Grates

A description of a new device which enables the loss of combustible in the ashpit of a chain grate stoker to be noted and controlled by the fireman.

By E. G. BAILEY.

THERE has been more guesswork and less knowledge regarding ash-pit loss than any other thing of equal importance in the boiler plant. It pays to watch the ash pile from every kind of stoker or even hand-fired furnaces, though it be only visual inspection to note whether it is well burned out or full of combustible. To sample and analyze the ashes regularly and calculate the heat lost in that manner is better still, yet it is done in comparatively few plants and falls far short of accomplishing the desired result. A sample taken from the entire plant each day leaves the responsibility divided between the different firemen and different types of stokers. To take a sample from each boiler for each shift would still not accomplish as good results as if the ash-pit loss were continuously recorded for each boiler.

Instantaneous readings of any kind are most valuable in aiding the fireman to obtain results. He can then see a faulty condition as soon as it takes place or even starts to take place, and remedy it promptly. If such readings are recorded continuously the fireman can see how quickly the remedy is effective. Such records also show the executive in charge of the plant just what took place at all times.

It is the purpose of this paper to present some preliminary data obtained from a device recently developed to record the ash-pit loss from chain-grate stokers. It may later be extended to some other types of stokers of either the present or modified design, but the great need for it on chain grates led to its being applied to these first.

Method of Recording Ash-Pit Loss.

The fundamental principle used in recording the ash-pit loss by this method is to place a temperature-recorder bulb at a point near where the ashes are discharged from the active section of the grate or furnace. The bulb is not in contact with the ashes but receives only the radiant heat from the coke being discharged. The relation between this temperature and the amount of combustible in the refuse, and the heat loss due to it, is established by taking a series of samples corresponding to different temperature readings.

If the ashes are well burned out, so that there are no live coals, the temperature is comparatively low. Even though the ash has clinkered rather badly and retained a certain amount of temperature, it has usually lost its glow and is comparatively cold from a radiation standpoint. The coke coming over is still ignited and at a temperature of about 1800 to 2000 deg. Fahr., so that its radiant heat to the bulb is sufficient to cause very decided changes in the temperature readings.

In selecting a location for the temperature recorder bulb, it is necessary to have it shielded from any radiant heat of the furnace itself, and also as free as possible from changes in temperature due to the surrounding brickwork, circulation of air, etc. It is further necessary that the bulb extend across the entire width of the grate and be so constructed as to obtain an accurate average in case the amount of coke coming over is greater on one portion of the grate than another.

Fig 1 shows an installation on a natural-draft chain-grate stoker with a 9 ft. bulb located just beyond the water back, which shields it from the heat of the furnace. It is located about seven inches above the rear end of the grate so that the radiant heat from any coke passing under it will increase its temperature.

The Temperature Recorder.

The temperature-recorder bulb itself is made very rugged to withstand this service. It is constructed of 1½-in. steel tubing with ⅛-in. wall and all joints welded. The bulb is charged with nitrogen and the gas pressure that is exerted by an increase in temperature is conducted through a 3/16-in. copper capillary tube to the recorder. The recorder consists of a simple mercury U-tube, one leg of which is open to the atmos- recorder is attached.

The other leg of the U-tube is made up of sections having different cross-sectional areas so that the pen movement is suppressed below and above the range to be recorded on the chart. It is also possible, if necessary, to have the area of one leg of the U-tube variable so that the percentage of heat loss will be recorded directly with uniform gradations on the chart in case the relationship between the ash-pit loss and temperature should not be a straight line.

The bulb can be made in sections short enough to be installed where the alley between two boilers is narrower than the width of the boiler itself. Each section, however, is welded permanently with ¼-in. No. 13 gauge steel tube, making a flexible connection so that it can be folded up and then straightened out as it is installed in the furnace.

Up to the present time the experiments have been largely confined to the selection of the best locations for the bulb with respect to the grade and also to determine the relative advantage of bare bulbs and those having lagging around a portion of their circumference so as to minimize the heat received from or given off to the surrounding walls, air, etc.

Fig. 2 shows the location of a bulb at the end of a forced-draft chain-grate stoker. A bare bulb was first located at position No. 1 with cast-iron supports. It was found that when the fuel was up to the bottom of the water back and there was a slight positive pressure in the furnace, a flame would envelop the bulb, sending the temperature up to more than 1500 deg. No data were obtained from this recorder in the No. 1 position.

The bare bulb was next placed on the cast-iron bracket in position No. 2, and after operating several days it was found to be satisfactory as to temperature range and continuous operation. A series of calibration tests was then started to learn what combustible losses corresponded to the different temperature readings.

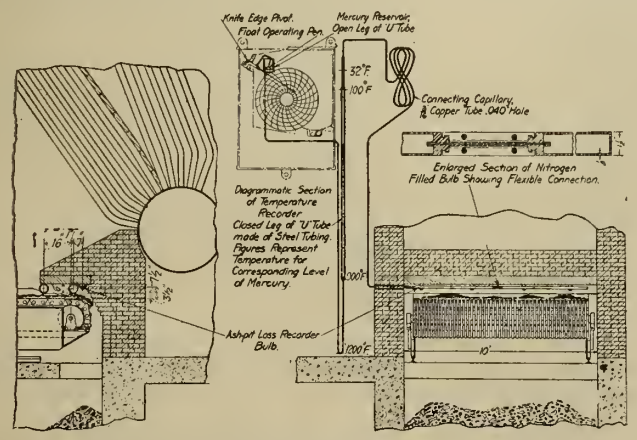


FIG. 1.—ASH PIT LOSS RECORDER INSTALLATION ON NATURAL DRAFT CHAIN GRATE STOKER.

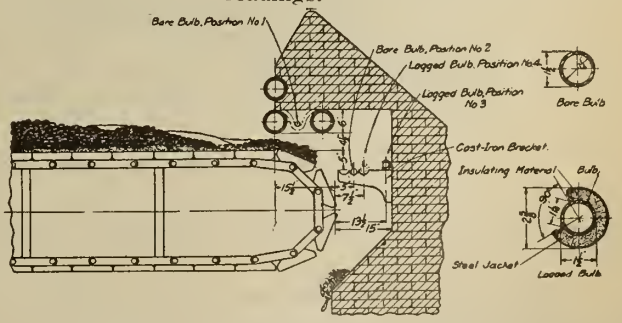


FIG. 2.—ASH PIT LOSS RECORDER ON FORCED DRAFT CHAIN GRATE STOKER.

Relation Between Temperature and Combustible Loss.

Samples consisting of all the ash discharged from the stoker were taken hourly. The ash as it accumulated in the hopper was quenched immediately by means of a water spray. At the end of the hour the ash was dumped from the hopper, crushed, mixed and quartered by hand until it was reduced to about 20 lb. of 4-mesh size, and sent to the laboratory. The analyses show combustible on the dry basis.

The samples from Station A were collected from time to time between January 20 and March 2, 1921, at times when it was convenient to do the work. Usually five to eight samples were taken each day. In all, 107 samples were taken during 15 different days. About half of them were taken during certain stoker tests that were being made on this boiler

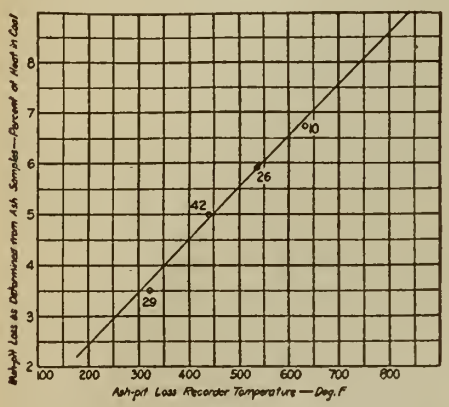


FIG. 3.—ASH PIT LOSS AND TEMPERATURE RELATION FOR BARE BULB IN POSITION NO 2. (FIG. 2) ON FORCED DRAFT CHAIN GRATE STOKER.

and the remainder under everyday operating conditions.

No special effort was made to change operating conditions from normal except in the case of a few samples, when more combustible was run over than usual in order to get some high points to establish the upper part of the curve.

The essential results for the 107 samples taken are plotted in Fig. 3, where each small circle represents the average of all temperature readings grouped between 300 and 400, 400 and 500 deg. Fahr., etc. It is noted that the ash-pit loss is about 3.5 per cent. at 300 deg. and increases 1 per cent for each 100 deg. temperature rise.

It was first thought best to plot the results between temperature and percentage of combustible in the ashes, but it was found that the ash in the coal varied between 8.5 and 14 per cent. From the curves of Fig. 4 it is noted that with samples having 30 per cent. combustible the heat loss is 3.9 per cent. from the 8.5 per cent. ash coal and 7 per cent. from coal with 14 per cent. ash, hence each test was figured on a basis of the heat loss due to unburned carbon, expressed in percentage of the heat in the coal.

The relation between percentage of combustible in refuse, ash in coal, and ash-pit loss is given in the series of curves in Fig. 4. These curves are plotted from the formula:

$$\text{Combustible loss} = \frac{100\,ac}{(100-a)(100-c)}$$

where a is the percentage of ash in the coal and c the percentage of combustible in the refuse. This formula is based upon the assumption that all of the ash from the coal goes to the ash pit and that the heating value per pound of combustible in the ash pit is the same as that of the combustible in the coal.

Emphasis is usually placed upon the percentage of combustible in the ashes as being the true measure of loss due to unburned carbon, but it is of equal importance to know the percentage of ash in the coal. There is more heat lost with 20 per cent. combustible in the refuse from a coal with 20 per cent. ash than with 40 per cent. combustible in the refuse from a coal with 8 per cent. ash.

One naturally questions whether the temperature of a bulb at such a location will vary with the percentage of heat lost or with the percentage of combustible in the refuse; whether either relation will hold true for different percentages of ash in the coal, or whether it varies with the boiler rating, grate speed, etc. The final answer to such questions can only be determined from results of actual tests. Fig. 3 is plotted from the 107 samples and it shows conclusively that the temperature varies directly with the percentage of the heat of the coal lost in unburned carbon. Various other plots and studies of the individual tests fail to show any tendency for the results to deviate from this curve due to changes in the percentage of ash in the coal, the grate speed, or the boiler rating.

This is very fortunate, as the temperature record can then be used directly in determining the heat loss without the necessity of bothering with percentage of ash in coal or any other modifying factors. In fact, the chart can be graduated direct in percentage of heat lost instead of temperature. Samples of coal and combustible are needed only for making the calibration tests, which should be determined for each type of installation. At least this will be necessary until more data have been obtained regarding location of bulb and the characteristics of different types of stokers, arrangements of water backs, etc., as these are likely to produce a different rate of temperature change as shown later in this paper.

Performance Results from Chain-Grate Stokers.

It is well known that with a chain-grate stoker the ash-pit loss tends to increase as the excess air is decreased, and vice versa. It is only natural that more coal should be wasted over the end of the grate when the fuel bed is kept thicker and carried to the water back. When the fire burns short a reduction is made in the ash-pit loss, but there is a decided increase in the percentage of excess air. As a matter of fact this is generally true in all types of stokers, and even in hand firing. That is, a reduction in unburned coal usually means some increase in excess air, so that decreasing one loss increases another.

The problem is then to determine what method of operation will give the lowest total loss, and the ash-pit loss recorder makes it possible to plot out these relations as combustion characteristics of the stoker.

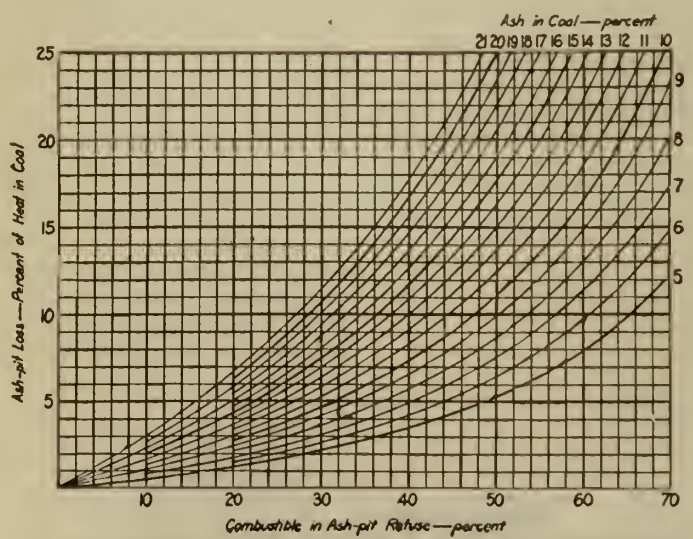


FIG. 4.—RELATION BETWEEN ASH PIT LOSS, COMBUSTIBLE IN REFUSE, AND ASH IN COAL.

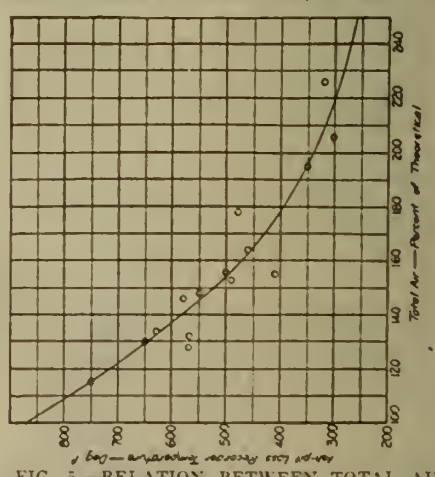


FIG. 5.—RELATION BETWEEN TOTAL AIR USED FOR COMBUSTION AND ASH PIT LOSS RECORDER TEMPERATURE OBTAINED FROM FORCED DRAFT CHAIN GRATE STOKER.

Relation Between Ash-Pit Loss and Total Air Used for Combustion.

Fig. 5 shows a very definite relation between temperature as indicated by the ash-pit loss recorder and the total air used for combustion on a basis of the theoretical air being 100 per cent. In plotting the points the total air was taken from the ratio of air flow to steam flow as shown on chart records, using only periods when the steam flow, the air flow and the ash-pit loss-recorder temperature were each very uniform

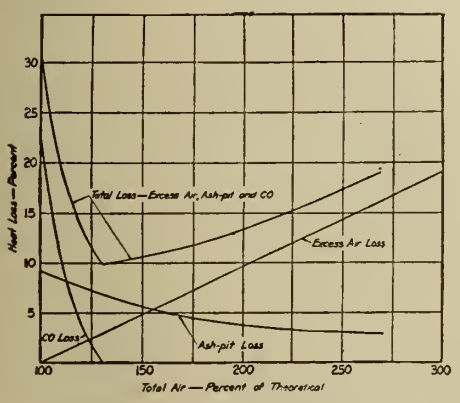


FIG. 6. — CHARACTERISTIC LOSS CURVES ON BASIS OF TOTAL AIR OF FORCED DRAFT CHAIN GRATE STOKER.

over stretches of two hours or more at one time, indicating that the conditions had settled to normal and were not varying continuously.

The values taken from the average curve of Fig. 5 are used to calculate the heat losses and are plotted in Fig. 6, showing the characteristic loss curves for a forced draft chain-grate stoker as operated in Station A. This set of curves shows that percentage of heat lost in excess of air (based on a 500-deg. temperature rise) increases from zero up to 19 per cent. at 300 per cent. total air. As the excess-air loss is reduced the ash-pit loss increases, but the rate of increase is less than the rate of decrease in the excess-air loss, so that the total of these losses decreases until the total air is about 130 per cent. At this point CO and unburned gases appear, and the percentage of heat lost in consequence increases very rapidly as the amount of air is reduced to 100 per cent. or the theoretical amount. It is therefore best to operate this stoker at about 130 to 140 per cent. total air.

It is quite possible that, with a little better care upon the part of the fireman, the combustible loss could be considerably reduced on this type of stoker, even at this low percentage of excess air. This would then lower the total curves so that the combined loss would be still lower than the 10 per cent. shown in Fig. 6 as the minimum point.

Relation Between Capacity and Stoker Losses.

Fig. 7 shows the relations between the boiler rating and flue-gas temperature, excess air, unburned combustible, and CO, with the percentage of heat lost in each. The total of these three losses is seen to be at a minimum of 11 per cent. at 225 per cent. rating and to remain below 12 per cent. at all ratings between 160 and 260 per cent.

The minimum loss in Fig. 6 is 10 per cent. because the excess-air loss is calculated on the arbitrary bases of 500 deg. Fahr. rise in flue-gas temperature, while in Fig. 7 it is calculated on the actual temperature, which is as high as 650 deg. at the higher rating.

If it were possible to operate this stoker with lower excess air at the lower ratings and lower ash-pit loss at the higher ratings, the total losses would be materially decreased and the curve would be flatter. In fact, the range of best efficiency as shown in Fig. 6 should be almost entirely independent of boiler rating if the same care is exercised by the fireman at the low ratings as he must exercise at the high ratings to produce the steam.

To obtain the total overall efficiency curves for stoker, furnace, boiler, and perhaps economiser, the other losses due to products of combustion and infiltration of air should be included according to the equipment used. There is also the question of overhead charges and repairs to stokers and brickwork that increases with higher rating or lower excess air.

Characteristic Curves of Stokers

This set of curves raises the question, can true characteristic curves be drawn showing the performance of the stoker itself? Very little has been done in this direction, but such data have been well established for centrifugal pumps, motors, turbines, fans and blowers.

In the operation of a stoker so much depends upon the character and quantity of coal being burned and also upon the human element of the fireman that the true characteristics of the stoker are usually so clouded that they do not appear in their true form.

Most boiler tests give combined efficiency of furnace and boiler as it is difficult to separate the two. In reality it is not necessary to separate these two efficiencies or even to determine the efficiencies at all, because a great deal more can be accomplished through studying the losses than can be obtained from knowing the overall efficiency alone. We know that if the losses are high the efficiency is low, and vice versa. It is also easy to separate certain of the losses and charge them directly to the furnace, while other losses may be chargeable entirely to the boiler and still others are beyond the control of either.

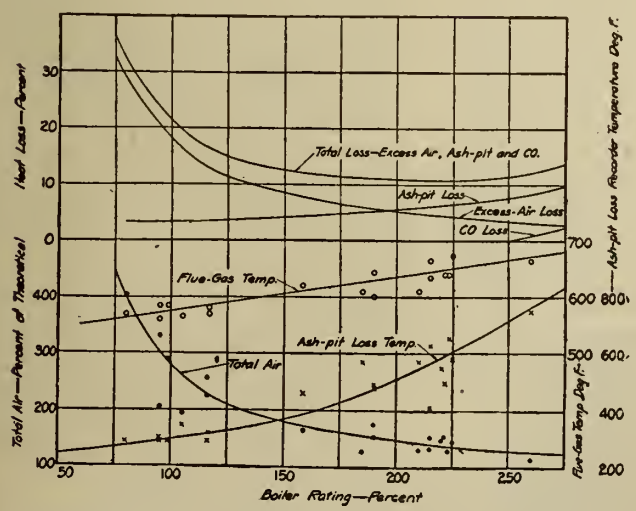


FIG. 7.—CHARACTERISTIC LOSS CURVES ON BASIS OF BOILER RATING, OF FORCED DRAFT CHAIN GRATE STOKER.

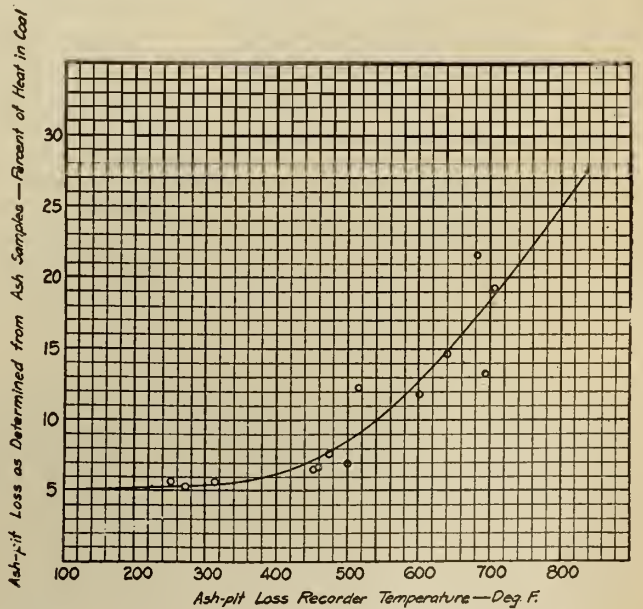


FIG. 8.—ASH PIT LOSS AND TEMPERATURE RELATION, BULB AS IN FIG. 1—NATURAL DRAFT CHAIN GRATE STOKER.

The three important losses existing in boiler and furnace operation that are chargeable directly to the stoker and furnace are unburned combustible in ashes, unburned gas, and excess air. The latter two losses may be influenced somewhat by the size of the furnace and com-

bustion chamber, and the last one by the leakage of air through the boiler setting, but on the whole they depend almost entirely upon the stoker and its operation.

If the characteristics of the stoker are properly determined one can then see the best relation between these factors in order that the total of the three losses be a minimum. We are then assured the furnace efficiency is highest even though we may not know the exact thermal efficiency of the furnace and stoker itself, separate from the boiler.

In operating stokers it has been considered that the character of the coal and the method of operation were far more important than the characteristics of the stoker itself. This, however, is only an admission that the stoker was not so designed that its characteristics would dominate over the other factors, namely, coal and fireman. Very great improvements have been made in stoker design and methods of operation, but there is need for still further advancement. A careful analysis of the problem by means of continuous graphic records of all the losses and characteristic performance curves like those shown in Figs. 6 and 7 will aid in further improvements in both design and operation as well as in selecting coal for the stoker or the selection of a stoker for the coal available.

Even where ash-pit loss recorders cannot now be easily applied to some types of stokers it is possible to take hourly samples of the refuse and plot the characteristic combustion and capacity curves like those in Figs. 6 and 7. For stokers with intermittent ash dumps the period for each test should be the same as the period between dumps, maintaining the operating conditions as uniform as possible during this period and taking the ash sample from each dump. As the value of these results does not depend upon coal weights and evaporation efficiencies, short tests are satisfactory for determining the losses due to excess air, unburned gas and unburned coal. All of the losses of the boiler heat balance, except radiation, can be determined almost if not quite as accurately as can be the evaporation.

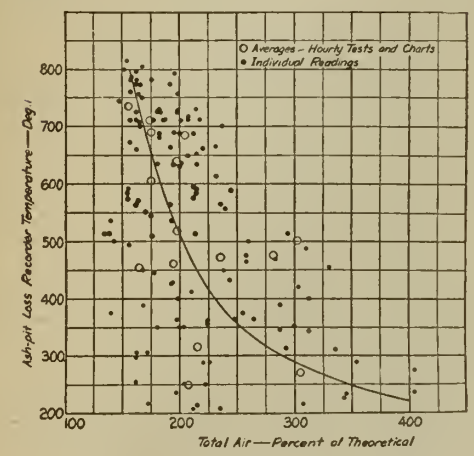

Per cent.
O Averages – Hourly Tests and Charts
• Individual Readings
Ash-pit Loss Recorder Temperature — Deg. F
Total Air — Percent of Theoretical

FIG. 9.—RELATION BETWEEN TOTAL AIR USED FOR COMBUSTION AND ASH PIT LOSS RECORDER TEMPERATURE OBTAINED FROM NATURAL DRAFT CHAIN GRATE STOKER.

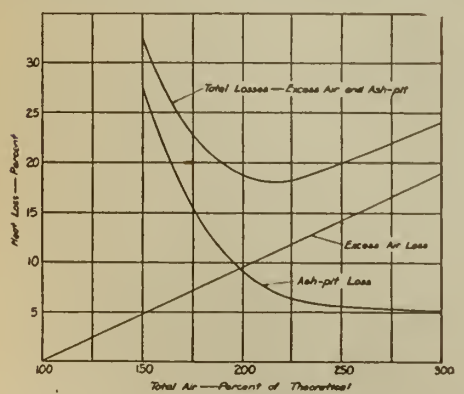


FIG. 10. — CHARACTERISTIC LOSS CURVES ON BASIS OF TOTAL AIR OF NATURAL DRAFT CHAIN GRATE STOKER.

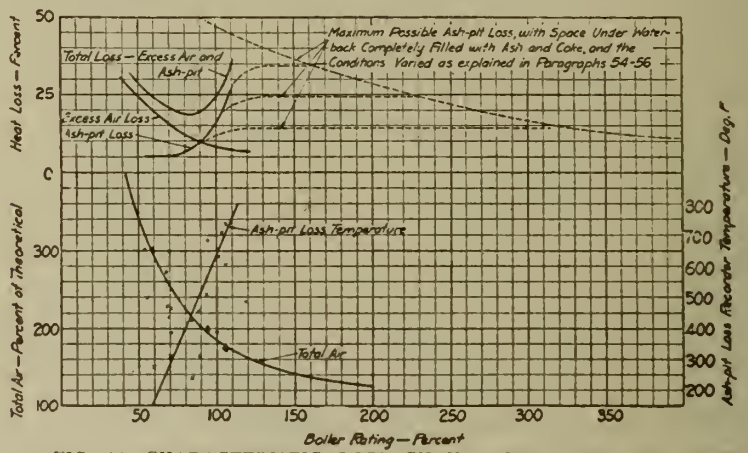

Maximum Possible Ash-pit Loss, with Space Under Water-back Completely Filled with Ash and Coke, and the Conditions Varied as explained in Paragraphs 54-56
Total Loss — Excess Air and Ash-pit
Excess Air Loss
Ash-pit Loss
Ash-pit Loss Temperature
Total Air
Heat Loss — Percent
Total Air — Percent of Theoretical
Ash-pit Loss Recorder Temperature — Deg. F
Boiler Rating — Percent

FIG. 11—CHARACTERISTIC LOSS CURVES ON BASIS OF BOILER RATING OF NATURAL DRAFT CHAIN GRATE STOKER.

diant heat. As soon as a few pieces of hot coke are carried over, the effect upon the bulb is very markd and a considerable rise in temperature takes place until the grate is covered with coke. A greater amount of combustible will add only to the thickness of the layer and not increase the area of the hot coke within the vision of the bulb in this location. The increase in the temperature of the bulb is due only to the closer proximity of the hot coke to it after the grate is once covered.

In Fig. 9 the relation plotted between total air and ash-pit loss-recorder temperature shows widely scattered points. This is largely because the fuel-bed conditions vary rapidly, and there is considerable time lag between the condition of the fuel bed on the grate proper and the amount of coke being discharged at the same time. The log, Fig. 12, plotted over a short period, shows a typical case of the variations as the fire burns thin and is again thickened. The ash-pit loss-recorder temperature drops with the short fire, but the lowest temperature is not reached until twenty minutes after the greatest air excess and the lowest steam flow.

The conditions of the fuel bed on this stoker are sometimes very good and sometimes very poor, just as it may happen, due either to the stoker characteristics, the human factor, or the coal factor, or to a combination of all three. In any case there are certain average conditions which tend to repeat and show the relationship between the various factors. It is very evident from Fig. 9 that very high excess-air and high ash-pit losses do not occur at the same time, although either may be low when the other is high, but they should both be low for the best efficiency.

In Fig. 10 it will be noted that the natural-draft chain-grate stoker in question, as it was being operated at this time, gives the best efficiency at about 210 per cent. total air, with a loss of 18 per cent. due to excess air and unburned coal. We all know that better results than this can be obtained under suitable load conditions with good operation and the right kind of coal, yet these curves indicate that there is a tendency for the losses to increase very

Results from Natural-Draft Chain-Grate Stoker at Station B.

Figs 8 to 12 give the data from thirteen ash samples and tests on a natural-draft chain-grate stoker equipped with an ash-pit loss recorder as shown in Fig. 1. These data were obtained on three consecutive days from a boiler that was being operated in a stand-by station. The load conditions did not require careful attention to the stoker operation, hence the results should not be taken as indicative of the best performance with this type of stoker. Neither should these results be used for comparing one type of stoker with another, because the operating factors, namely, coal and fireman, may be very different.

In Fig. 8 the ash-pit loss increases very slowly with the initial rise in temperature and then more rapidly at the higher temperatures. Referring to Fig. 1, it will be seen that the bulb is located at a different position with respect to the fuel bed than in Station A. In this case the bulb is directly over the end of the grate, and looks down upon the coke as it passes beneath it. With a very short fire the coke may "go out" or cease to burn before it reaches the water back and yet contain a considerable percentage of combustible, hence the minimum loss of 5 per cent, with little or no ra-

rapidly as the fire changes to a shorter or longer condition from the most economical point.

The air having free and equal access to all parts of the grate takes the path of least resistance through the fuel bed and develops holes very rapidly when once started. In many plants the boilers are operated with the damper wide open. If the maximum amount of steam is not needed the fire burns short. If more steam is needed the stoker is speeded up and a little greater proportion of the grate area is covered with active fuel bed. In other words, the steam pressure is regulated by means of excess air. Fig. 12 shows this very nicely, as the air flow remains practically constant and more or less steam is produced as the coal is fed into the path of the air.

Fig. 11 shows the excess-air and ash-pit losses plotted on a basis of boiler

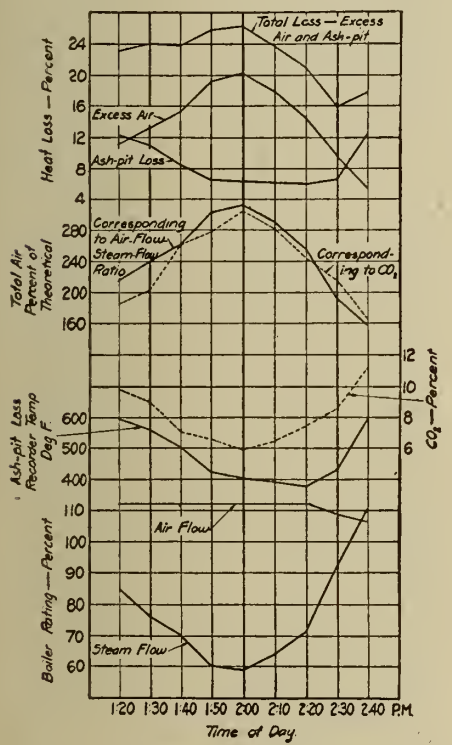

Total Loss — Excess Air and Ash-pit
Excess Air
Ash-pit Loss
Heat Loss — Percent
Corresponding to Air-Flow Steam-Flow Ratio
Corresponding to CO_2
Total Air Percent of Theoretical
Ash-pit Loss Recorder Temp Deg. F.
CO_2 — Percent
Air Flow
Steam Flow
Boiler Rating — Percent
1:20 1:30 1:40 1:50 2:00 2:10 2:20 2:30 2:40 P.M.
Time of Day

FIG. 12.—LOG SHOWING CHANGE OF FUEL BED ON NATURAL DRAFT CHAIN GRATE STOKER.

rating. The total of these two losses has its lowest value of 18 per cent. at about 90 per cent. rating. At lower ratings the excess-air loss increases rapidly and at higher ratings the unburned coal loss increases even more rapidly.

One naturally wonders whether the ash-pit loss would continue increasing at the rate indicated by the slope of this curve if the boiler were operated at still higher rating. The limit in this direction is reached when the space under the water back is completely filled with ash and coke. The percentage of combustible lost when operating with the space under the water back completely filled with ash and coke combined, will depend upon the percentage of ash in the coal, the coal-gate opening, and the height of the wafer back above the grate, and will be practically independent of the speed of the grate.

If the increased rate of combustion is obtained by increasing the gate opening and the intensity of draft, leaving the grate speed and the space under the water back constant for a given percentage of ash in the coal, a decrease in the ash-pit loss will result as shown by the upper dotted curve at the right of Fig. 11, because there will then be more ash per square foot of grate and therefore less space left for coke under the water back.

For any given relation between gate openings and space under water back the percentage of combustible lost would decrease with increased percentages of ash in the coal, and should of course remain constant for different ratings. A change in the height of the water back would also have a similar effect, the percentage of ash-pit loss remaining the same for all ratings in both cases so long as the space under the water back was kept completely filled and increased ratings obtained by increasing grate speed.

If the fire burns thinner, the ash-pit loss will be decreased for any of the foregoing conditions and the excess-air loss increased.

It is believed that characteristic curves like those shown in Figs. 10 and 11 will be very helpful in obtaining the best results from natural-draft chain-grate stokers. By means of such curves we should be able to accomplish better results in the arrangement of water backs, regulation of coal gate, grate speed, draft, etc., and also assist the fireman in obtaining the required amount of steam with the minimum loss.

SPLIT BELT PULLEY.

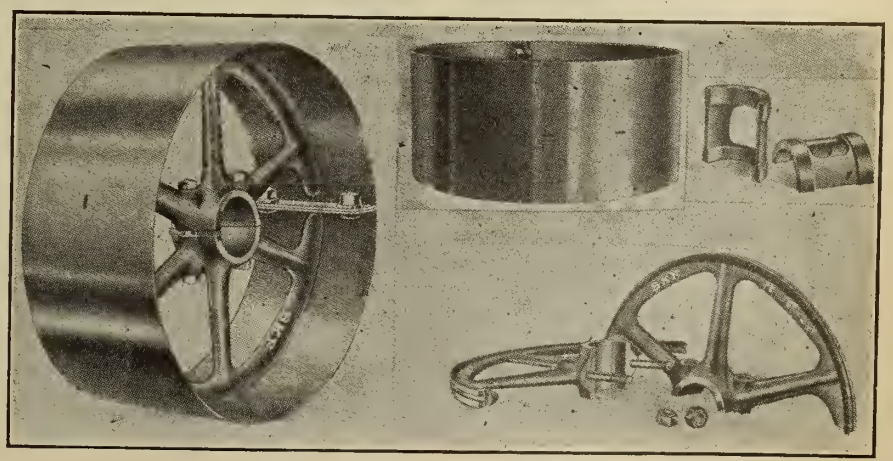
The S. K. F. Co., Ltd., Toronto, Canada, have placed on the market a line of new split belt pulleys which have some special features well worth mentioning. These pulleys are made in sizes from 8 inch to 60 inch diameter, these having a difference of 1 inch up to 24 inches, of 2 inches up to 40 inches, and of 4 inches up to 60 inches diameter.

Reference to the illustration tells the story in itself. As will be noted, the pulley consists of the following parts: A cast iron spyder made in two similar halves is provided with suitable fastening bolts. These halves are machined to receive interchangeable shaft bushes, or S.K.F. ball bearings of the adapter type as necessary. The periphery of the spyder is machined and a groove cut to receive the snugs (as they are called) formed in the rim by press tools, this, of course, preventing lateral movement of the rims. The adjacent ends are notched to locate rim balance weight.

The rim is made from suitable quality steel to withstand high tensile strength, and is finished by cold rolling. The ends are flanged and pierced to receive the two stretching bolts. A balance weight of sheet iron is placed within the rims when assembling, and is located by notches as already mentioned. No shaft keys are required on this style of pulley as they are intended for line shaft drives to machines or main drives to line shafts from electric motors.

The chief feature in this pulley is the interchangeable rim. Its advantage is self apparent, for rims up to 9 inches wide are interchangeable with those of lesser width on the same spyder and bush where necessary. Intermediate drives to line shafts, up to 2½ inch diameter, originally installed for continuous driving, may be converted for intermittent use by the substitution of a wider rim with flat face on the driving pulley, and the addition of a second driven pulley with crowned face, into which may be inserted ball bearings of the adapter type to carry the belt as a loose pulley.

It might be imagined that the adoption of the bushing system without keys would limit the use of these pulleys to light duty drives. However, this is not the case, for the company claims that they recommend with confidence these pulleys for main drives which are reasonably steady, such as those from electric motors to line shafts, driving machines in groups where a main belt is working at 3,000 feet per minute, or more; for instance, a line shaft speed of 250 r.p.m. transmitted through a pulley 48 inch diameter. It is, however, in the case of line and countershaft pulleys, where these pulleys will find their greater scope.



VIEW SHOWING DETAILS, ALSO ASSEMBLED PULLEY.

Using Hydraulic Tests as a Safeguard

Extract from a report to the Manchester Steam Users Association by their chief engineer Mr. C. E. Stromeyer. The author's position in the engineering world makes his statements of great interest.

By C. E. STROMEYER, M. I. C. E.

PROOF testing of completed structures is probably the most primitive method of determining their safety, and is still looked upon by the public, as reflected in the official mind, as the only safe method. Engineers, however, have long ago been dubious about its value, and prefer to rely on experiences which have gradually become sufficiently well defined to constitute a science. This Association has in a certain sense been a pioneer in throwing doubt on the infallibility of hydraulic testing of boilers, for it was founded for the purpose of demonstrating that boiler explosions could be prevented by thorough internal inspections, and it has been our practice to refuse to sanction the application of hydraulic tests to boilers before their strengths have been calculated; and no hydraulic test is considered complete unless it has been followed by an internal examination. Such examinations have frequently revealed fractures of stays and other parts, which had either been caused by the hydraulic tests, or, at any rate, had not been revealed by them. Quite recently a nearly inaccessible locoportable boiler was satisfactorily (sic) tested by hydraulic pressure without bulgings or other signs of weakness, yet on examining the boiler after the test, as far as this could be done through small hand holes, it was found that the three steam space stays, 1¼ inch diameter, had been broken off at both ends. A subsequent examination of these stays shewed that their material was bad.

The question may well be asked: Do hydraulic tests of vessels which cannot be examined internally offer any security against explosions? In attempting to answer this question we have to bear in mind the nature of inaccessible vessels subjected to steam pressures.

We have, first, a number of types of steam boilers which are too small and too complicated to be examined internally. Nearly all road locomotives belong to this class. Then there are steam pipe ranges. These pipes cannot be examined internally after erection. Cast-iron sectional boilers and many cooking vessels, drying cylinders, and chemical retorts are as a rule inaccessible for internal examination. Assuming that any of these vessels were so weak that they were on the verge of exploding at ordinary working pressures, then a hydraulic test would no doubt effect a rupture if it exceeded the working pressure, and although the damage to the vessel would be the same as if it had been caused by steam pressure, surrounding property would not suffer. In such cases hydraulic tests would be useful in definitely condemning vessels which, without such a test, might have been utilised for a lower pressure, but how are such cases to be selected without inspection? and, if selected and condemned, there should, of course, be no need for an hydraulic test.

Consider the case of a vessel which is subjected to fluctuating pressures, for instance a steam engine cylinder with its millions of changes of pressure per annum, or a steam pipe in which the pressure is turned on and off once a day. In either case fracture will ultimately occur if the intensities of the fluctuating stresses exceed the fatigue limit of the material. Suppose that these excess stresses amount to about 2 tons per square inch, then according to the law of fatigue we may expect failure after about one million revolutions. If these excess stresses were four tons, the life would be reduced to one sixteenth of a million. The higher the designed excess stress over the fatigue limit, the greater would be the fatigue effect of adding 50 or even 100 per cent. to it by means of hydraulic tests, and in a very rough sort of way it may be said that hydraulic tests do as much harm as thousands, or sometimes, tens of thousands of repetitions of working pressures. In fact, if by chance, and because of inability to calculate local stresses of complicated structures, these should exceed the fatigue limit by about 100 per cent., just about the level of the ordinary elastic limit, then, although the structure would stand about 50,000 repetitions of this rather severe stress, it would fail, or nearly fail, under a single application of the hydraulic test. Is it at all desirable that any vessel should have its life either cut short in this manner, or have it reduced by a large percentage every time that a hydraulic test is applied?

There is yet another aspect of this question. Probably all materials have ageing qualities. Badly annealed glass cracks after a time, due to a slow weakening of the material, associated with an increasing brittleness, or rather hardness, old glass being capable of blunting the edges of diamonds. Brass, and especially nickel alloys, change with time; so do the alloys of fusible plugs, and our experiments on a number of samples of steel have shewn that they age fairly rapidly. In good steels this ageing does not seem to affect the strength, but bad steels unquestionably deteriorate with time. Amongst these, Bessemer Steels are the best known example, and whenever they have been used for plates, first by Sir E.J.Reed in warships, the experience has always been the same—that such plates lend themselves to severe workshop treatment as long as they are new, but crack spontaneously some time after they have been riveted up. Hydraulic tests should reveal materials possessing treacherous quality, and have done so on occasion—witness the boilers of the Russian Yacht "Livadia"—but there are a far larger number of undetected cases, for instance the s.s. "Pahud" and her sister ship; and, at any rate, if they have passed the maker's hydraulic test, the chances are that subsequent annual tests would merely fatigue the rapidly ageing material and thus bring about an explosion at an earlier date than would otherwise have been the case. The possibility of such happenings is demonstrated by the occurrence, in countries, like Russia, where official annual hydraulic tests are carried out, of explosions and failures under tests of apparently safe boilers. The disastrous explosion of a dished end of a water tube boiler at Abo, in Finland, in 1917 wrecked the whole power station and stopped the industries of the whole town. The boiler had been satisfactorily tested (sic) three weeks before the explosion, and it is only too probable that this last test had extended an existing small crack till it reached to within one-twelfth of an inch of the outer surface of the one-inch plate. It is positively wicked to apply testing procedures which reduce originally low factors of safety to one-twelfth. The actual cause of these failures seems to be the use of basic steel made of Bessemer scrap. In England, where this material has not been used to any large extent, only a few shell failures have occurred, and these were due to the concentration of caustic liquors in boilers, whereby the steel was embrittled. In none of these cases was the hydraulic test of much use even after leakages had been discovered while at work. In a recent case these leakages were located by the hydraulic test and stopped by electric welding, and it was only when an adjoining vessel shewed persistent leakage which could not be stopped, that suspicion was aroused and that the first vessel was discovered to

have sustained a serious crack.

The hydraulic test has one merit in the eyes of those who resort to it—they know the official mind can be favourably impressed by the word "test," and that any person responsible for the safety of a boiler who can say that he tested it, has a better chance of escape from censure in case of an accident than he who may have carried out the most painstaking examination. Innumerable instances could be quoted from the Board of Trade reports, of remarks that hydraulic tests would have obviated explosion, while the alternative, that thorough inspections would have been still better safeguards is not mentioned.

Hydraulic tests are unquestionably in great favor amongst manufacturers. They reveal, or should reveal, when applied to new vessels, whether the material is bad, whether the workmanship is bad, and whether the draughtsman has been ignorant or made a mistake. Against this view it may be urged that designers should take more trouble than is customary to study local stresses, that the management should be so perfect that bad workmanship is impossible, and that the material should be effectively tested before use. It is a curious fact that the hulls of ships are not tested. The designer evidently knows his art to perfection, the material is reliable, and the one hundred to two hundred-thousand rivets are all tight, whereas the boiler of such a vessel, with only, perhaps, 2 per cent. of the above number of rivets, is tested. It would seem that the boiler is and the ship is not tested because the one can and the other cannot be tested. Under present conditions, proof tests by the makers or purchasers will, of course, continue to be made, but it must not be expected that they will offer an absolute guarantee of safety. (See first Table.)

There seems to exist a feeling that facts as represented by hydraulic tests cannot lie. Unfortunately they do not speak the whole truth, except in those rare cases where a hydraulic test actually bursts a boiler. This conclusion is arrived at by examining the following tables. The first one contains those cases reported on by the Board of Trade, in which the boiler or other vessel exploded within two years of delivery. In the majority of these cases, fifty in number, the makers will have tested these vessels; nevertheless in 33 years a large number of objects which were of weak design, or defective material or workmanship, survived the test only to explode shortly afterwards.

The second Table is of even greater interest. It contains all those cases reported on by the Board of Trade in which, on account of repairs or of changing hands, hydraulic tests were applied but did not reveal the defects which soon afterwards resulted in explosions. There are fourteen of these cases, most of them very instructive.

TABLE I.

Steam Boilers, Pipes, etc., which failed within two years of delivery. In most cases hydraulic tests will have been applied by the makers. In a few cases these are recorded.

Cast-Iron Steam Pipes and Cylinders

No. 1798—2 months; thin metal; hydraulic test, 200 pounds. No.1982—3 months; flaw in metal. No. 2179—10 days; thin metal. No.2306—39 days; bad casting. No. 690—17 months; thin metal; ⅛ inch. No. 1054—14 months; casting flaw; No. 2392; 9 months; casting flaw; hydraulic test, 300 pounds; 110 pounds working pressure.

Various Cast-Iron Vessels

No. 87—New—Heating table; weak set-screw stays; No. 119—New—Valve chest; thin metal. No. 414—New; flat side of engine; too weak. No. 13—New; De Coudon ironer; bad casting; hydraulic test 120 pounds; working pressure 40 pounds. No. 755—New; ribbed door; too weak. No. 896.—New; heating table; too weak; No. 1350—10 days; super-heater top; too weak. No. 1626—40 days; flat side of water catcher; too weak; No. 2010—2 days; horse-shoe steam dryer; casting flaw. No. 1242—2 years; ribbed door; too weak. No. 1322—12 months; heating table; too weak. No. 1567—2 years; De Coudon ironer; bad casting; No. 1930—17 months; top of feed pump; casting flaw; No. 2074—22 months; flat side of steam trap; too thin. No. 2136—8 months; heating table; too weak. No. 2370—2 years; vulcanizing press; fractured cast-iron stays.

Boiler Shell Plates

No. 265—7 months; longitudinal flaw in shell; No. 482—21 months; circumferential crack in shell; No. 1699—5 months; crack in root of dished end plate.

Various Vessels of Steel and Copper

No. 849—New; copper pipe of water-tube boiler too thin. No. 957—2 months; crack in flanged end of steel pipe; No. 1555—New; copper drying cylinder; defective joint; No. 1758—2 months; pipe weakened by threads at screwed-on flange; No. 124—8 months; cylindrical furnace too weak; hydraulic test 255 pounds; working pressure 120 pounds. No. 619—17 months; Cornish boiler, furnace oval 1½ inch. Hydraulic test 100 pounds; working pressure 25-45 pounds. No. 1201—18 months; defective tube connection in water-tube boilers; No. 1224—17 months; pipe weakened by threads at screwed-on flange. No. 1406—13 months; pipe weakened by threads at screwed-on flange. No. 1736—1 year; copper pipe; defective material. No. 1770—22 months; copper pipe; defective material; No. 1857; 2 years; pipe weakened by thread at screwed-on flange.

Defective Welds

No. 2133—3 weeks; welded shell of jacketed pan; No. 392—3 months; welded flat end plate of cylinder. No. 805—9 months; welded saddle boiler. No. 1237—18 months; welded end of annular boiler; No. 1580—7 months; welded heating boiler. No. 1890—6 months; welded boiling pan. No. 2166—22 months; welded-on flange of steam pipe. No. 2187—11 months; welded boiling pan; hydraulic test 120 lbs. No. 427—2 years; welded cross tube. No. 455—23 months; welded tube of water-tube boiler. No. 1045—12 months; welded steam pipe. No. 1221—2 years; welded tube of water-tube boiler.

TABLE II.

Steam Boilers, Pipes, etc., which failed within two years of being tested by hydraulic pressure.

Cast-Iron Vessels

No. 2039—Sectional water heating boiler, had accidentally been converted into a steam boiler; hydraulic test 100 pounds; burst 4 months later; pressure 7½ pounds. No. 1374—Conical casting, tested to 150 pounds when new, burst 10 months later at 90 pounds pressure. No. 1836—Cast-iron ring riveted to a steel shell; tested to 180 pounds; burst 3 months later at 120 pounds.

Boiler Failures

No. 221—Loco boilers; tested to 140 pounds; burst 2 months later at 133 pounds. No. 1326—Old marine boiler repaired and tested to 140 pounds. Burst 2 months later at 60 pounds. No. 180 Old loco boiler; tested to 70 pounds; burst 17 months later at 50 pounds. thickness 1-32 inch.

Cases of Grooving

No. 201—Old loco boiler; tested to 175 pounds; burst one year later at 120 pounds; thickness 1-64 inch. No. 344—Old loco boiler; tested to 185 pounds; burst 6 weeks later at 115 pounds; thickness 1-32 inch. No. 1493—Horizontal vessel; tested to 65 pounds; burst 2 months later at 45 pounds.

Cases of Extensive Wasting

No. 303—Old loco boiler; tested to 80 pounds; burst 2 months later at 66 pounds; thickness 1-32 inch. No. 607—Loco boiler; tested several times during four years to pressures of 130 to 200 pounds; burst at 60 pounds one month after last test of 130 pounds; thickness 1-8 inch; evidently a case of life being shortened due to fatigue effect of repeated hydraulic tests. No. 844—Old loco boiler; tested to 120 pounds; burst one year later at 42 pounds.

Broken Stays

No. 1370—Old loco boiler; tested to 200 pounds; burst seven months later at 120 pounds.

Wasting of Flat Plates Around Stays

No. 788.—Navy type boiler; tested to 100 pounds; burst 6 months later.

In addition to the above tables the following notes have been prepared for a special purpose, and are here inserted

as being of interest as regards the question of hydraulic testing, because they shew that, even amongst such inaccessible objects as drying cylinders, periodical testing could not have prevented these twenty-nine explosions, except, perhaps, a very doubtful one, No. 2476, in which case the defective internal drain had allowed water to accumulate and the soldered end gave way due to heavy weight in the cylinder. The steam inlet valve was found closed after the accident, so that this case is not really an explosion. The other cases are as follows:—

Nos. 81, 86, 249, 273, 1907, 2041, 2042 2169, 2253, 2255, 2284, 2361, tin plate cylinders, and Nos. 17, 163, 325, 1985, 2154, copper cylinders, failed in consequence of the absence of essential safety appliances. Hydraulic tests would not have prevented these explosions from occurring.

Nos. 652, 892, 1630, 1812, 2223, tin plate cylinders, and No. 2211, copper cylinder, failed on account of being worn out. Here hydraulic tests might have revealed the condition of affairs, but No. 2223 cylinder was repaired and tested to 20 lb. pressure only five weeks before it exploded at a pressure of 10 lb.

Nos. 920, 1140, 1743, tin plate cylinders, and No. 205 copper cylinder failed due to cracks which the respective plumbers had covered with solder. Hydraulic tests would not have revealed these defective repairs.

Nos. 86 and 2253, previously mentioned, revealed, when they failed, very careless workmanship as regards riveting, yet the hydraulic test on these vessels when new gave no indication of these defects. This is quite natural, for these vessels have large margins of safety, for instance, a duplicate of cylinder No. 2253 was tested to 119 lb. without leaking, though its working pressure was only a few pounds.

The above remarks apply with even greater force to cast-iron vessels, which are all designed to have very large factors of safety, which factors have to cover casting strains, wrong casting temperatures and shifting of cores, associated, of course, with local reductions of thicknesses. It may and does happen that a cast-iron pipe of nominally ¾ inch thickness may have been cast with a shifted core, resulting in the metal being say 1-8 inch thick on one side and 1⅜ inch on the other. Now although such a pipe has only one-sixth of its intended strength, and would very soon fail in practice, it would, if the thin metal were sound, be strong enough to pass the hydraulic test of double the working pressure.

IMPROVEMENTS IN COAL MINING

Closer attention to the economics of coal mining was urged by J. J. Rutledge, superintendent of the Central Experiment Station of the United States Bureau of Mines, Urbana, Ill., in an address delivered before the recent meeting of the Illinois Mining Institute. Changes which will reduce the cost of production and increase the amount of coal per unit cost are made necessary by the present condition of the coal market, Mr. Rutledge said.

"Coal is now selling with great difficulty," he said, "I have been told that screenings in Central Illinois are being offered for sale as low as 50 cents per ton, which is certainly far below cost of production. Lump coal does not seem to have suffered as badly as fine coal, but there has been some cutting of prices in this grade also.

"Some of the mines in the Southwest have not worked since last December. Others, railroad owned mines or mines supplying railroad coal exclusively, are only working from two or three days a week. One operator with thirty years' experience in the Southwest district told me he had never seen a condition like the present one. He said there was no market for fine coal, yet he could not help making some fine coal, if he was to make lump coal and the loss he was compelled to suffer on the fine coal would compel him to charge at least $15.00 per ton for his lump coal in order to come out even. One company had 56 'no-bill' cars of fine coal on the tracks and the railroads were refusing to furnish any more cars for the loading of fine coal".

Mr Rutledge urged that there should be some changes in the methods of working coal. Special attention should be paid to greater recovery. In many mines at present worked by the pillar and room system, the maximum recovery varies from 45 to 55 per cent and the remainder of the coal is left in such a condition that it is almost impossible economically to recover it. In others words, Mr. Rutledge said, the coal is irretrievably lost. By improved mining methods, such as panel long wall or pillar and room retreating, the recovery can be increased from 45 to 55 per cent, which is the present extraction, to 80 or 90 per cent, with a considerable reduction in the cost of production.

"If, by the expenditure of an equal amount of entry driving and brushing, from 25 to 35 per cent more coal can be recovered, mining costs can certainly be reduced by adopting the improved methods of mining", he said. "Estimates of the amount that it is possible to reduce the mining cost by improved methods of mining vary from 15 to 25 cents per ton. Moreover, the quality of the coal produced by these methods will be better than that produced by the old method and this will be an additional amount on the right side of the ledger. When our coal is gone, it cannot be replaced and is gone forever. Coal cannot be grown, like wheat, year after year."

Proper scientific study of subsidence would be of great economic importance, Mr. Rutledge said. As an example of the economic importance of such a study, Mr. Rutledge cited an important coal field where the pillar and room method of mining prevails. This field is now producing an amount of coal which has a royalty value of $300 per acre. Under a proper system of mining, involving good recovery, this amount should be increased to at least $500 per acre, the surface and coal being seperately owned. Is it not much better to mine this coal exhaustively and to neglect the value of the surface, when the difference between the coal and surface value is so great? he asked.

Mr. Rutledge also spoke for more rigid inspection of boilers, the use of improved devices for underground haulage to replace the slow, troublesome and expensive animal haulage, and the use of improved mining methods to decrease the necessity for coal washing. He also expressed the belief that underground loading machines will soon be found at work in many coal mines, even as they are now in many metal mines.

"One of the greatest defects in the present system of mining is the loading of slate and rock underground and the transportation of them to the surface to be deposited on the rock dump," he said. "Every car of rock or slate hoisted to the surface at least takes the place of one car of coal and possibly two cars. In other words, if the miners were not loading a car of slate or rock, they probably would be loading it with coal. The driver would be hauling coal, a revenue producing load instead of that which is only an expense and a waste. Moreover, it is necessary to maintain expensive dirt dumps on the surface in order to dump the dirt and this involves an expense. The haulage of heavy slate or rock in mine cars soon destroys them and tends to cause them to be in poor repair at all times. With a good system of mining, such rock or slate would be left underground where it belongs and where it certainly would do more good than on the surface. About the only use such rock or slate is put to after it arrives on the surface is for ballast on highways or railroads.

"Mine accidents and disasters are among the greatest sources of expense in mining coal. Under the dangerous methods of blasting coal off the solid that is followed in some states, fatal accidents to shot-firers are frequent. In one state, where blasting off the solid is almost universally followed, some mines have lost by successive shot-firers' explosions, as many as eight or ten shot-firers, that is to say, any one of several mines have had from eight to ten shot-firers killed in a period of time varying from eight to fifteen years. One mine is said to have actually lost fifteen shot-firers in twenty years of operation; one or two shot-firers having been killed at a time. The average amount paid for a shot-firer's death claim alone, not including damage to the mine and loss of output to the operator and of wages to the miners and other employees, has been from $3,000 to $3,500 each. Several recent shot-firer's explosions have cost

the mining companies concerned amounts varying from $20,000 to $50,000, including damages paid to heirs of deceased shot-firers and repairs to underground workings.

"Surely, it would be cheaper, speaking only from a cold, money-making standpoint, to abolish such a dangerous method of producing coal and endeavor to mine the coal by use of mining machines and permissible explosives."

AN UNUSUAL MODEL

The small photograph attached shows a picture of the Tower Bridge in London, England. The large photograph shows the same bridge made of Crane Valves and Fittings, and it is sent to you with the hope that you may find it sufficiently interesting to publish in your magazine.

This novelty was built at the Bridgeport, Conn. Works of Crane Co., and the only guide used throughout the entire work was the Postal Card view of the original bridge. This bridge is now on display at the Crane Exhibit Rooms, 23 W. 44th. St., New York, and later will be shipped to Crane-Bennett Ltd., London, England.

15358 pieces taken from regular stock, comprising 230 different kinds of Elbows, Tees, Crosses, Nipples, Valves, etc., were used in building the Bridge. 16251 Joints were required to make up the fittings, and it is worthy of note that not one left hand thread was used in the entire structure.

The Bridge is approximately 19 feet long by 11 feet high by 4 feet wide. The spans are 57 inches wide. It is of the Roller Lift Type having four towers, each tower being provided with one elevator. The lifts are 22 inches long by 30 inches wide.

The elevators are 6 inches square by 8 inches high. The upper part of the elevator cage being made by using a Brass Floor Flange with a Plug screwed in, into which the cable used for raising and lowering the elevator is fastened. The men operating the elevator are represented by Reducers, Nipples and Caps.

THE REAL TOWER BRIDGE.

The Towers are neat in construction and well proportioned, having four spires—one on each corner. These spires are neatly constructed by the use of Malleable Iron Reducers, Caps and Cast Iron Flange Unions.

The cables connecting the Towers to the approaches are made up of Nipples, Tees and 45 Degree Elbows.

Each approach is provided with two clocks bearing the name Crane-Bennett, Ltd.

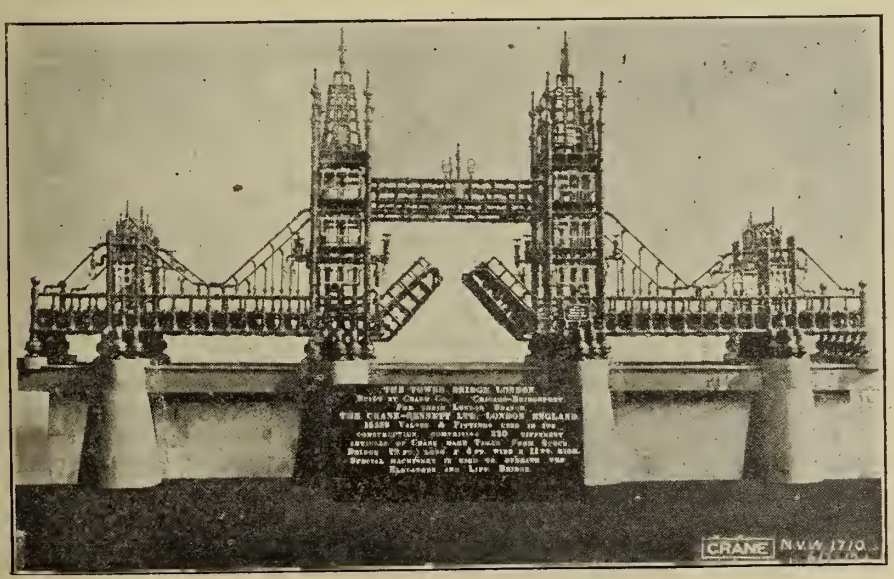
The Lifts and Elevators are raised and lowered by specially devised machinery. The reversing is done by an unusual mechanical movement and no clutches are used in its construction.

The Bridge is illuminated by thirty-six lights, eight being red and green for controlling traffic; four of which are used for navigation and four for traffic on Bridge. When the Bridge is closed the red light flashes and the green light extinguishes to show that the Bridge is closed to navigation. At the same time, the green light open traffic on the Bridge. When the Bridge is open, the green light flashes to navigation and the red light to traffic on the Bridge. 800 feet of wire was used to carry out the electrical effect.

In the sidewalks there are 1600 Right Hand Close Nipples, together with numerous Galvanized Tees, Crosses and Elbows. This has offered a great amount of speculation as to how the Elbows, Tees and Crosses were made up with Standard Right Hand Close Nipples, each fitting being not more than 1/16 inches apart, and is worthy of consideration.

The curb separating the sidewalk from the roadbed is represented by Galvanized Nipples slotted and slipped over a tongue which holds an amber glass roadbed.

The Bridge is mounted on skids covered with Granite Packing painted a wavey green. When looking through the amber glass roadbed onto the green Granite Packing, it gives a very good effect of the witching waves.



MODEL OF TOWER BRIDGE MADE ENTIRELY OF PIPE FITTINGS.

U. S. LIGNITE

Dr. Erich W. Zimmerman, consulting economist of the United States Bureau of Mines, has submitted to Director H. Foster Bain, a preliminary report on the marketability of beneficiated North Dakota lignite. The report analyzes the conditions surrounding and the difficulties affecting the fuel supply of North Dakota, South Dakota and contiguous territory. The ultimate purpose of this study is to provide the necessary economic data upon which an estimate of the commercial possibilities of beneficiated North Dakota lignite may be built up. The report specifically deals with coal production and consumption in the territory mentioned; Northwestern fuel prices; Northwestern fuel imports with special reference to their sources; the Lake coal trade to the Northwest, and the railroads and the Northwestern fuel supply.

Overhauling and Adjusting in the Engine Room

In this article the mechanism of the simplex pump valve is described. The first example chosen is the Darling pump, which is a typical example of this style.

By "FITTER".

THE VALVE motion of a simplex type of pump must necessarily be of a different character to a simple rotary engine or a duplex pump. In the duplex pump we have the two rods, each of which can be employed to operate the valve of its neighbor, and providing continuous motion once the pump is started. With the simplex pump however we have only the one rod, and some means have to be adopted to enable the piston to reverse at the end of its stroke, and in working out the details of this some ingenious motions have been devised. It is our intention in these articles to explain the motions on the better known types of simplex pumps, so that the young engineer and perhaps some of the older ones may become thoroughly acquainted with these various mechanisms.

The arrangement adopted in practically all cases, a combination of two valves, one the main valve which admits steam to the piston, and the other a small valve which is used to admit steam to a piston which works the main valve. This auxiliary valve is worked by the pump rod through a lever, and though the details of ports differ in different makes of pumps the broad principles are the same. The valve gear of a simplex pump may then be summed up as consisting of a lever, driven by a roller attached to the pump rod, with its upper end arranged to move the auxiliary valve spindle, the auxiliary valve and the main valve. A simple arrangement surely, but one that can be very troublesome if it is neglected, as many of our readers probably know by painful experience.

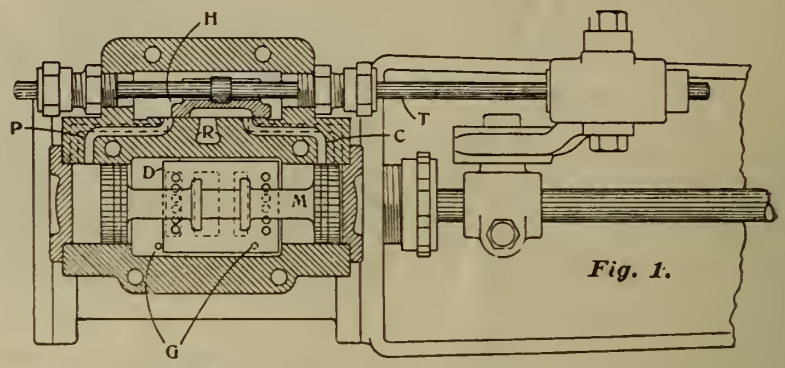


Fig. 1.

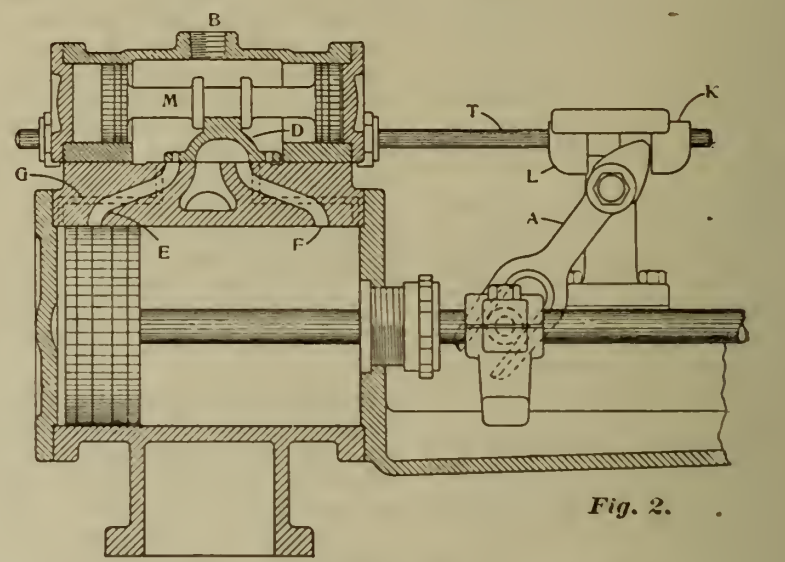


Fig. 2.

SECTIONAL PLAN AND ELEVATION OF VALVE CHESTS.

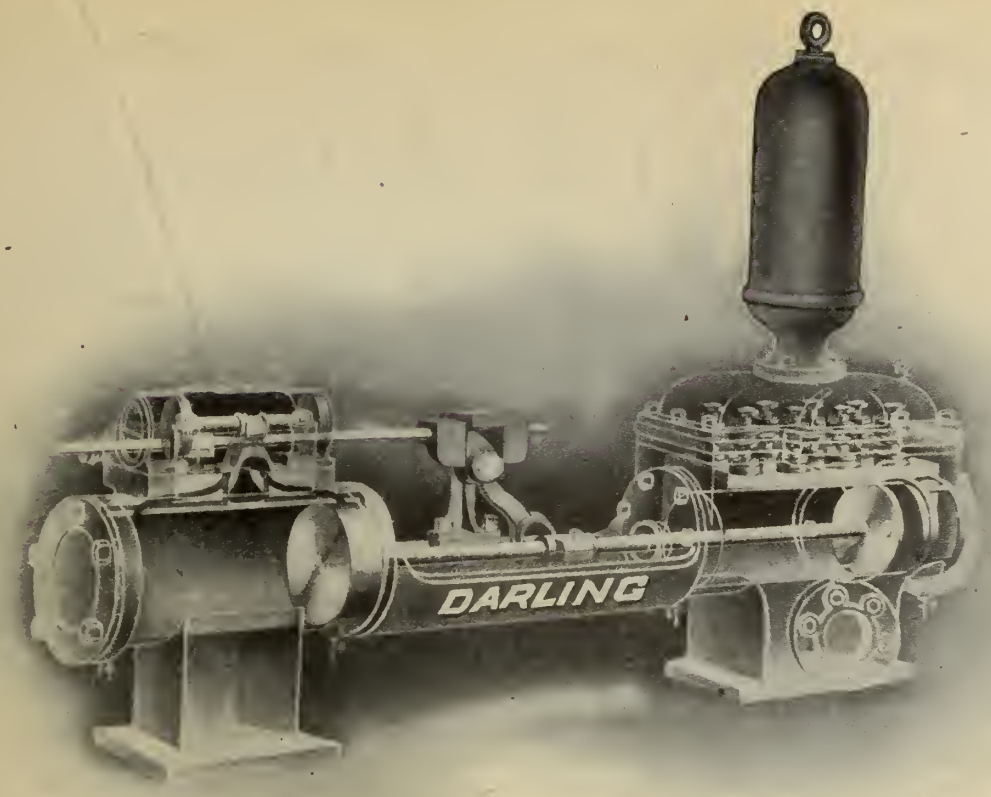
The Darling Pump

The first example we will take is that of the Darling pump, which is a good example of this type, and by following the description and the cuts the operation can be very clearly seen. The top cut Figure 1 is a sectional view looking down on the steam chest, showing the main and auxiliary valves, while the lower cut, Figure 2, shows a vertical section through the pump, the main piston, the main valve, and the valve piston being shown. The various ports can be clearly seen.

Looking at the top cut, we see that the auxiliary valve H is a plain D slide valve, fastened to the valve spindle, which is driven by the lever attached to the frame. The lower end of this lever fits over a roller which is carried by a bracket clamped on the pump rod, and as the end of the lever which drives the valve spindle is above the fulcrum, the valve spindle is moved in an opposite direction to the piston rod when the pump is working. The auxiliary valve has live steam on the outside and the cavity communicates with the exhaust in the usual manner. Its function is merely to move the piston to which is attached the main valve D. The two lugs L and K on the valve spindle are made adjustable, so that the instant when the auxiliary valve will be reversed can be varied by the engineer, thus making the stroke of the pump slightly longer or shorter according to necessity. Perhaps we should say giving a little more or less cushioning rather than a shorter or longer stroke.

Looking at the top cut again, we see there are two ports in the auxiliary valve chamber, P and C and these communicate with the ends of the main valve driving piston. Shown in dotted lines are two other ports, behind the first two, and extending to the extreme end of the casing in which the piston works. The object of these two ports is to supply a small amount of steam at the very beginning of the stroke of the piston, so that it will start up gradually, and have moved a little way before it gets the full amount of steam from the main port. In the position shown in the cut, the piston of the pump, or the main piston, has just reached the end of its stroke at the outer end of the cylinder. The lever has moved the auxiliary valve spindle to the outer end of its stroke and the auxiliary valve has thus given steam through the port P to move the main valve piston over to the front end of its stroke. In doing this the main valve D has also moved over to the right and is now open to give steam through port E to move the piston back to the other end of the stroke. However, as we see in the lower cut, this port E is blocked by the piston, so that no steam can reach it while in that position. There is behind the main port, and shown in dotted lines an auxiliary port G, and this port is open to the small clearance space behind the piston. Thus there is available a small amount of steam to start the piston on its stroke, and start the water in motion slowly until the piston uncovers the main port, when it will gradually come up to speed. Thus there is no sudden shock and lifting of valves when the stroke is started.

Now let us follow the piston to the other end of its stroke. As it moves forward carrying the lever with it, the lever will gradually straighten up, the valve spindle remaining stationary, until half



PHANTOM DRAWING OF PUMP

stroke is reached. After that the lever will swing towards the block L, until as the rod reaches the end of its stroke the auxiliary valve spindle will be moved over to the left and the main valve also thrown over ready to give steam to the opposite side of the piston.

While the piston has been advancing, the port F has been open to exhaust, and will remain so until the advancing piston covers it. There is then a certain amount of steam in the cylinder, and this being trapped, will form a cushion for the piston, bringing it gradually to rest. It cannot escape through the auxiliary port as that is covered by the main valve. Thus the piston comes to rest and starts from rest very slowly and evenly, and this greatly helps the life of the valves, joints, etc. by doing away with shock and the vibration attending thereto. The effect of altering the position of the lugs K and L will be apparent from the foregoing description. If they are brought close together, the lever will have a smaller arc to travel through before moving the valve, and thus the valve will be reversed at an earlier portion of the stroke thus making the stroke shorter. This will also mean that instead of the piston being brought to rest by the compression of the steam in the cylinder, the valve will open to steam before the end of the stroke is reached and the clearance space will be partially filled with live steam, thus causing a loss. On the other hand if the lugs are separated, the pump will have to reach the extreme end of the stroke before the valve is moved, thus tending to sluggish working, and in extreme cases, to complete stoppage. Somewhere between these extreme positions is the correct position for the lugs to be secured to the spindle, and this can be found without much trouble.

When the pump is at half stroke and the lever vertical, the lugs are set an equal distance on each side of the lever. The pump is then started, and the lugs adjusted until the pump is working with the full length of stroke and without any shock or jerk. There is really nothing to go wrong with this gear, and cases of pumps sticking can be traced usually to a lack of lubrication, too tight packing, or too wide adjustment of the lugs. Of course, the wear on the roller should be noted, and when necessary a new one put in, as if there is much slack on the roller, or on the lever end between the lugs the pump won't function properly. There is another word of warning which is perhaps very necessary to some men. If you have one of these pumps and it sticks, don't resort to banging the valve spindle or the end of the chest with a hammer. Of course it very often succeeds in starting the pump, but on the other hand if the valve was clean and sufficiently lubricated it would not need any persuading with a hammer. Besides if any one were looking through the plant and saw a pump, with the valve spindle and valve chest covers bearing the marks of hammer blows, they would at once conclude that the man in charge wasn't much of an engineer. The valves don't need smothering with oil, but they do need an occasional overhaul and cleaning, and perhaps a little facing up, at which time a good dose of oil will help them to get a surface after starting up again. Too much oil is as bad as too little, it usually becoming a hard greasy mass. The valves will wear a good clean hard surface for themselves, and there is usually enough moisture in the steam to provide lubrication. As in every other thing in the engine room, intelligent care will eliminate trouble, and there is nothing at all in the valve gear itself to cause one moment's worry. It is well designed and as simple as such a gear can be made.

PETROLEUM STANDARDISATION

The Technical Committee on Standardisation of Petroleum Specifications plans an open meeting in the offices of the United States Bureau of Mines in Washington, Tuesday, July 12, at 10.00 a.m. eastern standard time, for the consideration of suggested modifications and additions to Bulletin 5, which contains the specifications under which governmental purchases of gasoline, kerosene, fuel and lubricating oils are made.

From the standpoint of the oil trade the most important change proposed is the addition of a corrosion test to the specifications for motor gasoline. Some of the gasoline recently purchased has been found to be corrosive, and a test has been proposed to insure against a repetition of the trouble.

A few new specifications to cover products not now listed in Bulletin 5 have been suggested. Other modifications have been proposed, looking to improvement in the manner of making some of the tests.

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POWER HOUSE

JULY 5th, 1921

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The C. A. S. E. Convention

THE CONVENTION of the Canadian Association of Stationary Engineers just concluded at Ottawa, and fully described in another portion of this issue, was a very great success, both for the members of the Association and the representatives of the various supply firms who comprise the Exhibitor's Association.

The exhibition itself was much more complete than in former years, and was the finest kind of illustration of the progress of power plant engineering. Mr. C. B. Turner who had worked very hard for the success of the event, claimed that not even at the Toronto exhibition could such a complete survey of power plant apparatus be made. We are inclined to agree with him in this, and we believe that these exhibitions and conventions are the finest possible medium for awaking the interest of the general public to obtain a closer understanding and acquaintance with a branch of engineering that lends so much to their daily comfort. It is a good place for the manufacturer also to get a line on the developments that have been made towards the economic running of his power plant, and it would be encouraging to see more of this class of visitors at the conventions. Every manufacturer is looking for cheap power, but we venture to state that a good many of them could get cheaper power if they were to keep in closer touch with their engineer, and get acquainted with some of the modern apparatus, which placed under his intelligent care, would help him to the desired goal.

The President and officers of Ottawa Lodge are to be congratulated on their efforts towards the success of the convention, which were ably backed by the President and officers of the Exhibitor's Association, and between them they succeeded in making the convention one that will be long remembered, by all those who had the privilege of attending.

The Hydraulic Test

MR. C. E. STROMEYER, the Chief Engineer of the Manchester Steam Users Association, and a very widely known authority on the subject of steam boilers, has some interesting things to say in his annual report on the subject of steam boilers. Mr.Stromeyer states without any equivocation that the hydraulic test is responsible for a large number of boiler explosions, and that "it is positively wicked to apply testing procedures which reduce originally low factors of safety to one twelfth."

This statement coming from a man with the authority of Mr. C. E. Stromeyer should make some of our wiseacres pause. In this country it is an unfortunate fact that the hydraulic test is looked upon as a sort of unfailing oracle, that cannot lie. Experience has shown that it can lie, and lie disastrously. Mr. Stromeyer has something else to say which contains a great deal of truth, and these are his words:—"The hydraulic test has one merit in the eyes of those who resort to it:—they know the official mind can be favorably impressed by the word test, and that any person responsible for the safety of a boiler who can say he tested it, has a better chance of escape from censure in case of an accident than he who may have carried out the most painstaking examination."

We have taken the opportunity on former occasions to bring this viewpoint before our readers as we have had a good deal of experience among men who thought that the hydraulic test was the be all and end all of boiler inspection. These men in a good many cases occupied important official positions where their view point had a great deal of influence with those they came in contact with. We know of cases of boiler explosions in this country which we believe could be traced to the hydraulic test as the fundamental cause, and we know that the hydraulic test is being conducted to absurd limits every day all over Canada. Of course it is not only in Canada that this takes place, as the hydraulic test is insisted on by the British Board of Trade, which has a very wide experience in boiler construction and rules, but they limit their pressure to one and a half times the working pressure of the boiler, and make careful inspection before determining that working pressure. The great danger is that some men, possessing that little knowledge that is a dangerous thing, use the hydraulic test as a means of determining the working pressure. The danger of such a course must be apparent.

We are publishing in full that part of Mr. Stromeyer's report which deals with hydraulic testing, and would earnestly recommend its perusal by all those who have any interest in steam boilers, whether they are engineers, inspectors or owners.

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Cutting Generators In and Out of Operation

Turbine Running—Putting Generator on Line—Changing Over Machines—Phasing—Changing The Voltage Regulations—Changing Over to Standby Central Station Service—Cutting In Generators.

By J. A. McGillivray.

THIS article is intended to help the operator in small isolated power plants to master the important details of putting machines into and out of service and the operation of switch boards. Where possible, these instructions should be supplemented by personal instruction and practice, under a practical power plant operator. For convenience we will assume that a plant is already equipped and ready for operation, and so as to cover the subject pretty thoroughly let us assume that the equipment consists of the following:

2-Steam turbine driven 3 phase A. C. generators having direct connected compound exciters, with a separate steam driven exciter, compound.

2-Synchronous motor generators or converters.

2-Automatic A. C. voltage regulators. The switch board equipped with Power Factor Meter, Frequency Meter, etc. Oil switches handthrown. A duplicate set of Main Generator busses. Duplicate outgoing feeder circuits. 2-Step up transformers for power distribution. 2-Step down transformers for lighting.

A standby A. C. and D C. connection from Central Station service. The plant is to run continuously without interruption to local service, 24 hours a day and 7 days a week. There is to be kept in reserve one set of everything. The standby service to be used only in case of accident to steam mains or boilers, or other emergency. The change from isolated station service to central service is to be made without interruption to local operation.

"Turbine Running," Putting Generator on Line.

Building Up.—If T. R. positions are not already marked on the rheostats, proceed as follows: Note the range of the voltage regulator, let us suppose that it is from 70 to 140 volts, that is when the regulator is connected across the exciter shunt field resistance. The exciter voltage is automatically controlled between those limits when the rheostat is turned in to a point where the voltage by hand regulation would be 70 volts. (If the rheostat is cut in to a point where the exciter voltage by hand regulation would be 80 volts it would reduce the range of the regulator, that is, the regulation would be automatic between the limits of 80 and 140 volts.) Let us then assume that the point to which the exciter shunt field rheostat is turned, when there is no load on the exciter and the exciter voltage is 70 volts is the correct T. R. position. Mark it. Now you may connect the exciter to the exciter busses having all other switches on the board open. Next close main A. C. generator field switch and build up A. C. voltage to normal using A. C. field rheo, with the exciter shunt field rheo in T. R. position. The position of the main generator field rheo is T. R. position when A. C. generator voltage is normal, mark it. You may now close the main generator switch. (We may call the units (1) and (2) for convenience).

Putting Regulator in Service.

1st.—Close D. C. magnet single pole switch. This energizes the D. C. magnet; now move the exciter shunt field rheostat until the short-circuiting contacts just open or vibrate and close the single pole switches corresponding to No. 1 machine.

2nd.—Check the operation of regulator by gradually cutting OUT main generator field rheo, and note that the main generator voltage remains constant or nearly so. Cut out gradually until the exciter voltage is increased automatically over the full range of the regulator, or until the main generator field rheo is entirely cut out. If the regulation is not good over the entire range refer to the instructions given with the regulator. But it might be well to bear this in mind. The average station operator has no business to attempt adjustments farther than dash pot adjustment and counter-weight adjustments, as the regulator is a delicate instrument and not to be monkeyed with unless he possesses more than average knowledge of its principles. The connections should be gone over carefully as most of the regulator troubles are due to the following causes:

1st. Wrong T. R. position.
2nd. Dash pot too free or dampened too much.
3rd. Commutator trouble.
4th. Bad contacts.
5th. Wrong connections.
6th. Wrong adjustments of magnet cores.
7th. Wrong spring adjustments.
8th. Insufficient condenser capacity, causing arcing at contacts.
9th. Line drop compensating connections not properly made.

The first four are easily and safely investigated by any operator. The others require expert attention.

While the automatic regulator may be said to be a delicate instrument, once properly adjusted it is the most reliable and permanent instrument in the Power Station. The only attention it requires is to renew the contacts from time to time and keep the oil in the dash pot about ⅛-inch from the top, and to throw the reversing switches at least once every watch.

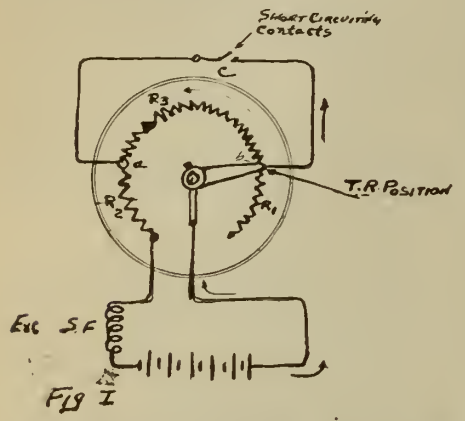
3rd.—Close whatever feeder circuits are required and close the secondary transformer switches. Then the Primarys close whatever lighting switches that may be needed.

4th.—Start the motor generator or rotary. If self-starting type close the starting switch, which is simply a compensator like that on any ordinary motor. Be sure the motor generator field is open before attempting to start. If the field switch happens to be closed even though the rheo be cut in there will usually be sufficient field current to build up a field of sufficient strength to prevent the motor from starting. At the same time there will be sufficient starting current admitted to overheat the windings in a few moments, and probably break the insulation down. When the motor generator is coming to synchronous speed you will observe the amperage falling off gradually and steadily to a point where it no longer falls off steadily, but swings up and down across the scale. Now close the field switch cutting out a small amount of resistance until the ammeter shows no reading. (The time required to do all this is from one-half a minute to one and one-half minutes, depending on the size of the machine and the period required to bring it into synchronous speed).

Next take the starting switch in one hand, the running switch in the other, disconnect the starting switch and instantly close the running switch. It's easy to do with practice. Should you fail to get the running switch closed at the first attempt, do not try it a second time, as the interval of time will be sufficient to let the motor fall out of synchronism and should the main or running switch be closed the generator tends to pull the synchronous motor into step or synchronism instantly with all the available energy of the prime mover behind it, a great surge of current is sent through the motor causing the squirrel cage starting coils to become distorted and fouling the stationary element probably destroying the machine. Therefore, if you fail in the first attempt, start all over again with the starting switch. A synchronous motor is really an alternator and while there are various methods of synchronizing or bringing to speed it is important that the operator bear in mind that he is not simply starting a motor, but is par

alleling two alternatives, which will be explained later on.

5th.—Having the synchronous motor generator in the line the next operation is to put the D. C. end in service. First cut in all the resistance in D. C. shunt field and close field switch, bring voltage to normal, close circuit breaker, then the main switch, close feeder circuit breaker and feeder switches and adjust voltage as load comes on.



While these instructions require considerable time to write them and will require some time to study them, the operations outlined "with the exception of marking the rheostats" can be executed by an experienced operator in from 3 to 5 minutes, but the beginner had better go slow at first.

Now, apart from operation there is no more worry until it is time for the operator to change over machines, without interruption to service.

Changing Over Machines.

First.—Paralleling Exciters. If the station load is not too variable it will be most convenient to parallel the exciters without the voltage regulator in service, since the function of voltage regulation is performed by automatic short circuiting of the exciter shunt field resistance. Thus increasing the exciter voltage to pass a larger current through the alternator field, "the resistance of which is constant," and vice versa. The understanding of this principle stumps most operators, but once they get the idea the rest is easy or comparatively easy to understand.

A reference to Fig. 1 may illustrate the principle in a simple way. The condensers are not indicated but their function will be described.

Let Fig. 1 be a closed circuit with external resistance R. Let a shunt be connected across points a. b. and the resistance R divided into three parts in series R-1, R-2, R-3. If the rheo is turned in to point b, which is T. R. position R-1 and R-2 are constant factors, R-3 is cut in when contact c. is open, and cut out when contact c. is closed. Now let it be for example that the load requirements are such that at any instant the resistances required are (R-2 +½R-3) then if contact c. is closed half of the time and open half of the time we have the equivalent of R-2+(R3-2) having established this fact clearly in your mind you may proceed to study up the regulator and you will have little difficulty. The contact points (c.) could not last a great while no matter what they were made of owing to the arc that accompanies the breaking of a closed circuit carrying a current. The function of the condenser is to condense this arc or choke the discharge when the circuit is broken by the opening of the contacts. The contacts are made of platinum, this metal being able to withstand high temperatures.

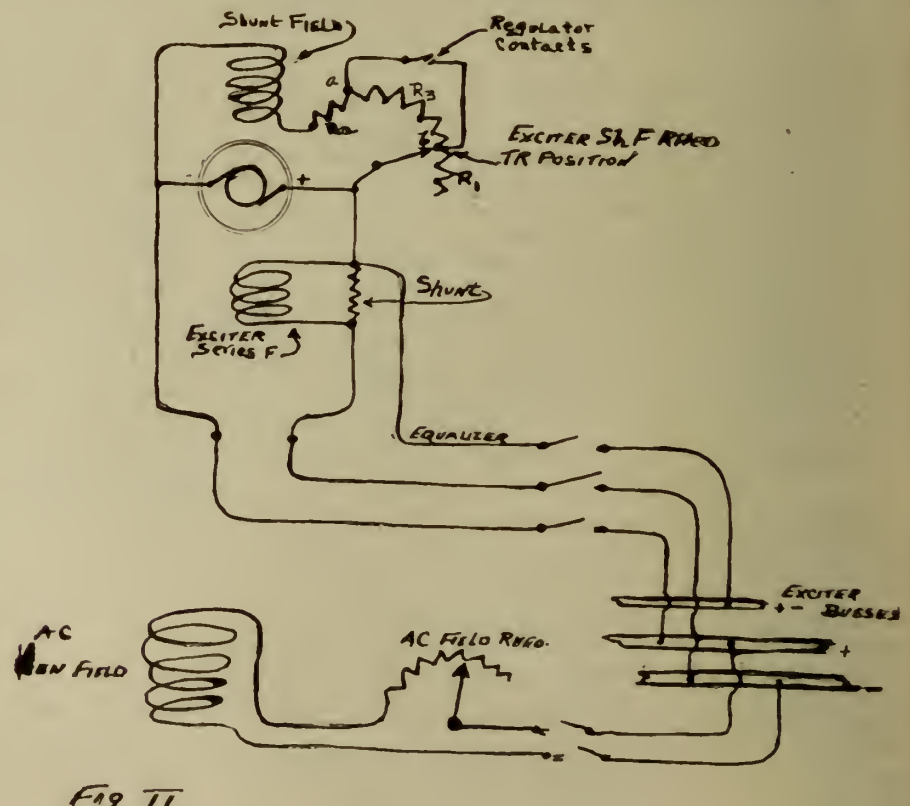
Now as already stated, the regulator may be cut out if the load is fairly constant, or the assistant may regulate the main generator voltage by hand regulation of A. C. field rheostat, while the exciters are being parralleled. The expert operator will, however, parallel the exciters with the voltage regulator in service, thus:

Build up exciter No. 2 a little higher than No. 1, watch the swings of No. 1 voltmeter, when the two voltages are similar close exciter main switch (the switch is usually 3 pole, one pole being the equalizer) when exciter switch is closed, close single pole switches on regulator which correspond to No. 2 machine and set exciter rheo. at T. R. position, then close No. 2 A. C. field switch and build up voltage with the rheostat. Now it may happen that the load on No. 1 machine is so heavy that the exciter buss voltage is sufficient to build up voltage on No. 2 when the rheo. is all in, and this voltage may be in excess of normal, preventing paralleling under those conditions. Where this is a common occurrence the remedy is to insert more resistance in the A. C. field, but until such time as this can be done there is another way out of the difficulty and if very little extra resistance is required it may not be worth while to go to the trouble. This method is to cut out some A. C. resistance out of No. 1 by moving the A. C. rheostat away from T. R. position, thus reducing the voltage at the exciter busses.

When A. C. voltage is about normal try out all three phases of the incoming machine. The voltage across the phases will be or should be the same, and will not necessarily be equal to the line voltage, as this depends on the way the windings are connected, but the voltage must be the same for each of the three phases of all machines that are to run in parallel. Slight unbalancing may be noticed in the loaded machine due to lighting circuits. (See note*).

Note. The installation of small lighting transformers in a plant are sometimes a source of unbalancing as some departments may be using lights while others are not. The amount of unbalancing is rarely important. when it amounts to much balancer sets are installed.

If it is noticed that one phase of the incoming machine is not showing voltage while the voltmeter shows normal voltage some of the fuses in the instruments may be blown, make sure. When this is attended to plug in the synchroscope and proceed to bring No. 2 into synchronism, using the motor control for this, if none installed the engineer must control the turbine governor with hand wheel. The operator will have been told whether to synchronize with dark or bright lamps, if not he mustn't take a chance. He can find out by disconnecting the main generator leads from the oil switch (be sure not to reverse the leads; we assume that the machines have been pha[illegible]) or any convenient place away from it, but between it and the generator. In the gap connect a



temporary 3-pole switch with fuses, say 100 amp. to 200 amp., low enough, of course, not to injure the machine. Now get synchronism with either dark or bright lights and close No. 2 main generator switch at moment of synchronism. If the generator switch can be closed without blowing the fuses that condition is right. If fuses have blown it does not prove conditions are wrong, as the operator may have made a bad throw that is while he may have had synchronous speed the machines may have been out of phase somewhat. It is better to try it a number of times until positively certain.

The difference between paralleling A. C. and D. C. generators is this: In the latter case the only requirement is equal voltage and the same polarity; in the former the requirements are equal speeds. Equal voltage, equal phase angle, or in short synchronism means all of those things. There may be equal voltage and equal speed and still be 180 degrees out of phase at the instant the switch is closed. If the speed of both machines is exactly the same and the machines are out of phase they can never come into phase without a variation in the speed of one or the other.

Since it is the writer's desire to help the operator who is confronted with the problems of operating switchboards as far as possible and to avoid technicalities that serve only to confuse rather than enlighten the average engineer, I will endeavor to explain in a few simple words what is meant by being in phase.

First let me say that it is not really necessary that he, the operator, should know, but that it is nevertheless useful to understand. The understanding of these things may be rungs in the ladder that is to carry him higher in the operating field. There are boys operating switch boards of large stations safely and reliably who do not know the first thing about the phasing out of a generator, all they know is that if they make a bad throw they will hear about it. They are not allowed to do it twice on the same job. They are shown by an expert what to do, they learn it and do it automatically. The fact that they do not realize what it amounts to contributes to their success as operators. They will not be subject to nervousness as they do not worry. A good operator is seldom a careful operator. I do not mean this literally, not only is this true of operators, but in many walks of life, some of the most successful engine drivers and hoist men I ever knew were the most reckless—some of the most unfortunate were the most careful. Some of the readers of this article will remember one of the most careful and conscientious hoisting engineers who ever pulled a throttle, had a great many accidents costing human life, finally broke down mentally, to the genuine sorrow of all who ever met him. A man of fine intellect and great generosity and more than common learning, hundreds of engineers, the writer among them, felt that they lost a personal friend. I would not counsel carelessness, but would warn the engineer against nerves.

Phasing.

The armature windings of a 3-phase generator are connected in 3 groups. From each group a lead is taken to a separate buss bar. Let the groups of coils, their leads and their busses be a., b., c. If another 3-phase generator is to be paralleled with No. 1, the same lead from the same corresponding group must be connected to the same buss bar, etc. Not only must this be so, but the same group in each machine must be cutting the same pole at the same instant and at the same speed of rotation as if fixed on one shaft, one group may not be entering a zone during a cycle while the other is leaving it; in other words, the same coil must be in same position under their respective poles at the same instant.

A cycle is the cutting of a pair of poles, in a two-pole machine a cycle is one revolution and equal to 360 degrees. The phase angle or phase difference will be the difference in the relative positions. Let coil or group a. be at zero degrees of the circle; let the coil or group a. of the machine to be paralleled be a quarter cycle ahead or behind, the phase difference is then said to be 360-4=90 degrees, or 90 degrees apart. The greatest possible disturbance is when an attempt is made to connect the machines when 180 degrees apart, at this value the difference is maximum. To illustrate: If you lay off a circle, take a point on that circle at its circumference, any other point on the circle that is less than 180 degrees is measurably less distant than a point 180 degrees. It is immaterial whether one machine slows up or the other speeds up; the phase difference becomes less.

When positive that everything is in order, the main switch of No. 2 generator is closed at the point of synchronism, the generator A. C. field rheo. is turned to T. R. position and the load is taken over on No. 2 machine by manipulation of the turbine govenor.

When ready to close down No. 1 generator proceed as follows:

Cut in A. C. field resistance in A. C. generator No. 1 again to T. R., change the exciter load over to No. 2 by using the equalizing rheostat. Disconnect No. 1 exciter from the exciter busses and from the regulator. Be sure that you disconnect the single pole switches that correspond to No. 1—there is no hurry. Take your time and watch your moves. Having the exciter clear you may give the engineer the signal to close down. When he does so open main switch No. 1 and immediately cut in all the resistance of A. C. field or there will be a tendency of the voltage on the machine going too high. You may leave the A. C. field switch in until the speed of the machine falls off, then open field switch.

The order to close the steam off before opening the main generator switch may be a little surprising, but I'll explain. An A. C. generator connected into the line with another machine will run in synchronism with that machine, electrically locked until the switch is opened. (This is not true of a D. C. machine, don't confuse the two.) Now if the switch is first opened and the turbine shut down last the voltage of the machine may, owing to heavy load on No. 2 and consequent high exciter voltage at exciter busses, be excessive, making it urgent to get the prime mover closed down quickly or else opening the A. C. field switch and breaking a strong field which is not desirable. Certainly the amount of resistance in the A. C. field may be sufficient to reduce the generator voltage to normal or less. If so, then it does not matter which is done first, a great deal must depend on the local conditions. The main thing is to avoid haste which is always contributary to false moves and to say the least undignified.

Now the feeders may be changed, putting in No. 2 and cutting out No. 1 without interruption. The same is true of the transformers. Closing the secondaries first and primaries last.

Changing the Voltage Regulators.

Close single pole D. C. magnet switches on No. 2 regulator, then single pole shunt field short circuiting switches. Now the two regulators are in parallel and the contacts of No. 2 should be vibrating, 1. 1., opening and closing. When No. 1 can be disconnected by opening the single pole switches in the reverse order to putting into service, for further instructions see instruction books.

The motor generators can now be changed over. Start the synchronous motor as already described. Voltage is now built up on the D. C. end, to about 1 or 2 volts above the busses, put in main switch (D. C.) and equalizer, take the load over on to No. 2 by adjusting equalizing rheo., then open No. 1 circuit breaker and equalizer and open motor A. C. switch, cut in A. C. and D. C. rheostats and when machine is about stopped open field switches.

Operating in Parallel on Peak Loads.

It may be necessary to operate both A. C. and D. C. machines in parallel on peak loads. The only problem presented is equal load division. D. C. machines will usually divide pretty well without much annoyance once the rheostats are adjusted. Of course they may require occasional adjustment. The A. C. machines will require careful adjustment of the A. C. field rheostats in order to operate at good power factor. The ammeter and K. W. Meter readings may or may not be an indication of the true load. A reference to the feeder ammeter should check up substantially with the sum of the two A. C. generator ammeter readings. When this is so and the power factor is good, there is no further adjustment required so long as the turbine governors are of the same

type and sensitiveness. In getting equal load distribution it will be necessary to adjust both the turbine governor and the A. C. field rheostats.

The synchronous motor excitation is so adjusted as to improve the power factor. A synchronous motor may be considered as a condenser of large capacity for condensing wattless current as well as load capacity.

Changing Over to Standby Central Station Service in Emergency.

The first thing to do is to synchronize the station with the standby line. This operation is exactly the same as synchronizing two machines, since that is what it amounts to, except that you bring the loaded machine into step with the central station, and adjust the station voltage to that of the line which may be slightly above or below the standby line value. You can do this when the difference is not greater than 15 per cent. up or down by adjusting the spring tension on the floating main contact of the regulator. When voltage is right and the point of synchronism reached close central station switch as described for generator.

You may now disconnect the regulator and cut exciter voltage down some before disconnecting main generator switch closing down the entire machine.

If standby D. C. is required the Station D. C. bussbar voltage must be brought to the same value as the standby when the standby switch may be closed and the station C. B. tripped. To change back again to station service reverse the operation. Note that the feeder circuits and transformers have not been interfered with. If the spare exciter is to be put in in an emergency it will be put on the exciter busses as already described for equalizing the exciters.

D. C. voltage regulators are practically the same as A. C., except there is no A. C. magnet. With compound wound D. C. generators voltage regulators are rarely necessary, as the total current generated passes through the series field and as the load is increased the field is correspondingly strengthened. A small winding called the Shunt Winding carries a small amount of current that can be increased or diminished for initial voltage adjustment. If the machine builds up too high a voltage where the load is increased it is said to be over compounding, and if it falls off it is said to be under compounding. This is partially remedied by putting on shunts to divert some of the current from the series field when the machine overcompounds and taking off shunts where undercompounding. If the regulation is poor it may be necessary to install voltage regulators. Under certain circumstances any variation whatever is objectionable—the limit of variation being one or two volts, or say 1 per cent. With a variable load the only solution is the installation of voltage regulators. In some cases a variation of 5 or 6 per cent. is not considered serious, and in such cases the regulation is always by hand.

Cutting In Generators.

Question.—Will you please tell me through your Power House columns how to put D. C. and A. C. generators on the line, also something about Switch Board operation? Our line voltage is 600 V. A. C. and 250 D. C.

Answer.—To answer this question properly will require too much space in the Question Box Department. It will be taken up elsewhere. A brief description of the operation however is as follows:

D. C. generators "starting up" with all switches open and no machines in line.

1st. Start the prime mover in the usual way and when up to speed.—

2nd. Note that the rheostat is turned in, that is all the shunt field resistance cut in.

3rd. Close field switch (single pole) some small installations have no field switch, the field being always closed.

4th. Build up voltage slowly by turning rheostat in the direction to raise voltage.

5th. Close circuit breaker.

6th. Close main switch.

7th. Close breaker on feeder circuit if there is one.

8th. Close feeder circuit switch.

9th. Adjust voltage with rheostat if voltage falls off with load.

Be sure to close C. B. before closing switch because if there is trouble on the line the circuit breaker will automatically clear the line the instant the switch is thrown in.

Taking D. C. Generators Out of Service.

1st. Open Feeder C. B.

2nd. Open Feeder Switch.

3rd. Cut in shunt field rheostat.

4th. Open C. B.

5th. Main Switch.

6th. Close down.

7th. Open field switch.

Note.—It is not really necessary to open field switch if care is taken to have the rheo. cut in, but should the rheo. be cut out there will be no resistance in the field and if the generator is started up with the field switch in the voltage may be high enough to break down the insulation.

Paralleling D. C. Generators.

Build up voltage on incoming generators as already described. If the generator on line has load build voltage on incoming machine up to about two volts higher than the line voltage. When this has been attended to close C. B. on incoming machine and close main switch. Lastly close equalizer switch, then equalize the load with equalizing rheostat or with generator shunt field rheostat, if there is no equalizing rheostat.

Taking D. C. Generator Out of Service Where There Are Two or More Generators on the Line.

1st. Reduce load on the generator to be disconnected. Do this carefully, letting the load be gradually taken over on the other machine, by slowly cutting in resistance in the outcoming machine. When load has been reduced open C. B. and main switch and close down prime mover.

In case of an emergency requiring quick shut down of one machine when there are two or more in service, simply open C. B. and main switch. The worst that can happen is a heavy swing of load on to the other generators, with consequent line disturbance. Always get the generator disconnected from the switch board before closing down the Prime mover.

The subject of cutting in and out A. C. generators is treated fully in an article appearing in this issue.

INSPECTING CLOSED BOXES BY X-RAYS

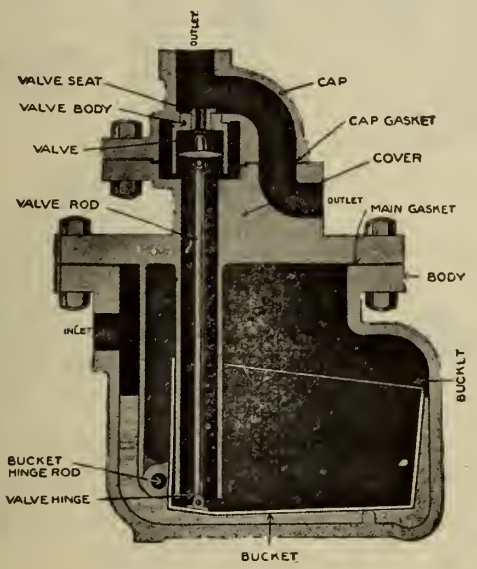
X-rays are a form of light which has the power of penetrating substances which are opaque to ordinary light. The more dense the substance the less it is penetrated, so that the rays falling on a composite body, such as a box with metal nails and hinges, throws a kind of shadow picture of the hidden parts on a photographic screen. This fact has been utilized in the examination of manufactured articles. Recently a British Government Department brought out a portable X-ray outfit for examining large numbers of boxes, without opening them, in order to see whether they contained all the essential parts. The apparatus is placed on wheels and is solidly built to stand rough use in the workshop. In place of a photographic plate a fluorescent screen is used so that the operator can actually see the shadow picture thrown by the contents of the boxes. By the use of this equipment an immense amount of time has been saved in the inspection of thousands of articles.

THE BRITISH INSTITUTE OF PHYSICS

The first scientific institutions in the world were formed in Great Britain; and to-day almost every branch of science is represented by a powerful body of British experts. The increasing specialization of scientific work has led during late years to a rapid multiplication of such bodies, the latest to be formed being the Institute of Physics recently inaugurated in London. One of the main objects of the Institute will be to afford increased assistance to research in pure science. Great Britain has always been pre-eminent in this branch of progress and it has achieved results of epoch-making importance at a wonderfully small outlay. With improved organization and increased resources it is expected that Britain's lead in the advancement of knowledge of the constitution of matter will be increased.

Strong Steam Traps

Save every Ounce of Steam



The Strong Steam Traps automatically remove the condensation from the systems or machines to which they are connected, and increase the efficiency of the machines themselves. This is made possible by the pumping or siphoning effect of the trap action upon the condensation in the steam apparatus.

The service rendered by Strong Steam Traps in respect to increased machine output at lesser cost, has resulted in the standardization of Strong Traps by a great many of the largest steam trap users in the world.

Strong Steam Traps are built extra heavy throughout and by changing the valves and seats, the same trap may be used under any pressure from zero to 200 lbs. In case of the discontinuance of a certain system, the traps may be removed and installed for other service.

The Strong Steam Traps are so constructed that only a few minutes are required to renew the only wearing parts, the valve and seat (no piping to disconnect).

Each Strong Steam Trap, upon completion and before being shipped, is carefully inspected and tested and leaves the factory in perfect working order and ready to go into service without any adjustments being required.

Our nearest Sales Office will send full information and prices on request.

If it isn't here write us.

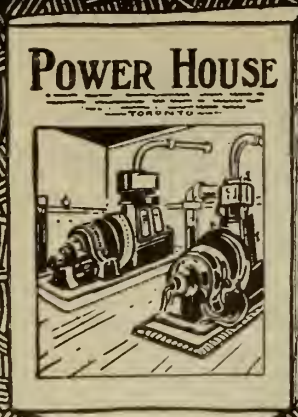
Pump Governors
Float Valves
Fan Engine Regulators
Lever Balanced Valves
Relief Valves
Pratt & Cady Valves
Durabla Packing
Palmetto Packing
Pipe, Fittings

THE CANADIAN FAIRBANKS-MORSE CO., LIMITED

Canada's Departmental House for Mechanical Goods

Halifax	Ottawa	St. Catharines	Winnipeg	Calgary
St. John	Toronto	Windsor	Regina	Edmonton
Quebec	Hamilton	Fort William	Saskatoon	Vancouver
Montreal				Victoria

Fairbanks-Morse



Obligations

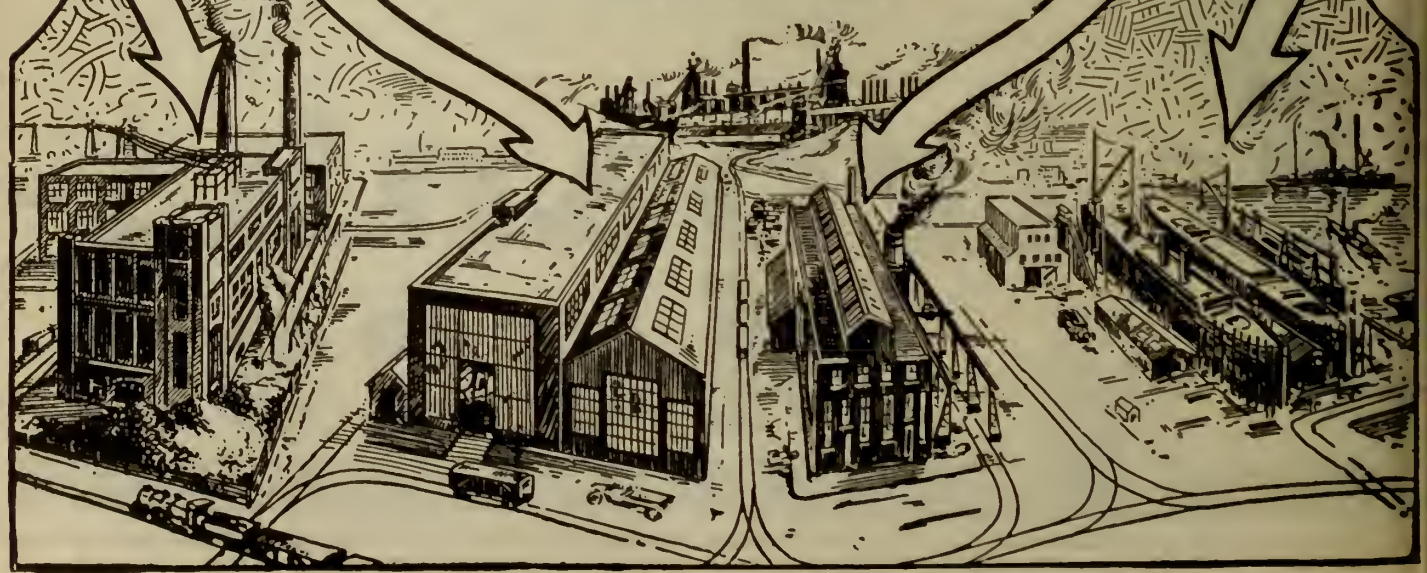
These four dominant factors of Canadian industry —Power House, Canadian Machinery, Canadian Foundryman, and Marine Engineering—are all members of the Audit Bureau of Circulations and of the Canadian National Newspapers and Periodicals Association.

These memberships entail obligations which are a protection to both subscriber and advertiser. The first requires perfect frankness with regard to circulation. The second, that the subscribers' and advertisers' interests shall receive first consideration. MacLean Publications give their clientele absolute protection as well as service of a high order.

The MacLean Publishing Co., Limited

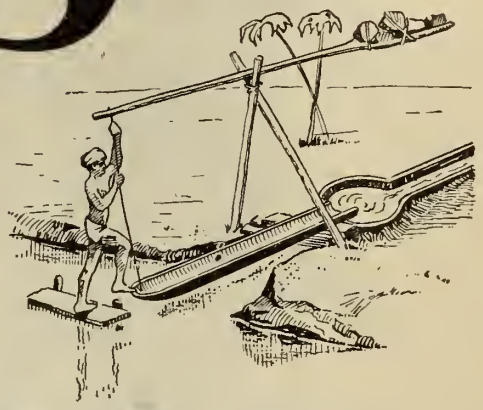
Toronto Montreal Winnipeg Vancouver New York
Boston Chicago London, Eng.

Trade and Technical Newspapers and Magazine Publishers



PUMPS

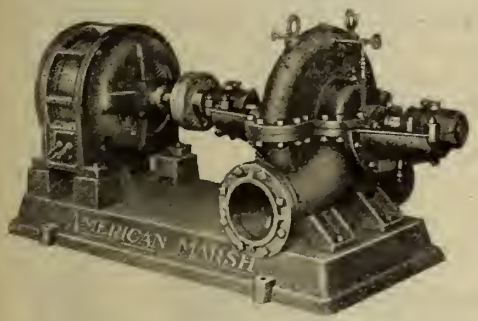
The Doon is simplicity itself. One end of trough dips into pool—stone weight comes down—trough tilts up—water flows into ditch!



In Oriental countries a tremendous amount of human labor is expended in comparatively small achievement. About the only recommendation of the Doon method of "pumping" is simplicity! This same elemental requirement—simplicity—is a vital principle of American-Marsh Pumps. They are built to render heavy and effective service.

American-Marsh Centrifugal Pumps are made in both single and double suctions, solid and split case patterns.

Write for American-Marsh bulletins.



Type HM Motor Driven

AMERICAN STEAM PUMP COMPANY
Battle Creek, Michigan

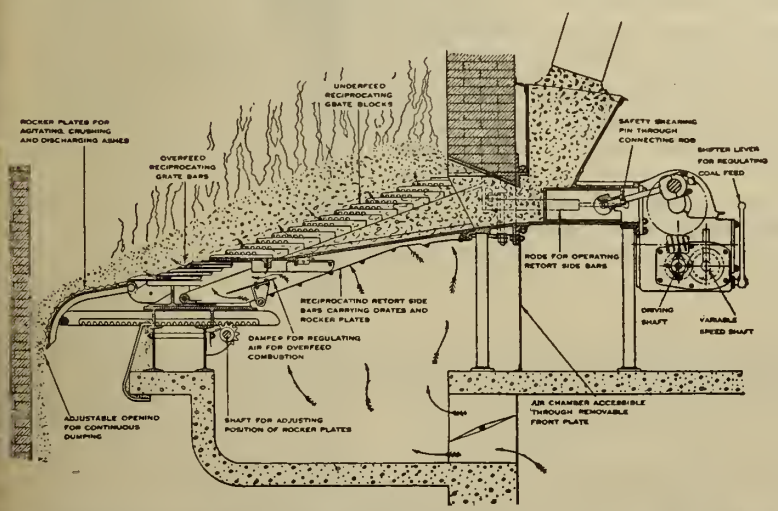
CANADIAN AGENTS

A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd.,London. A. R. Williams Machinery Co., Ltd., Winnipeg. Mechanics' Supply Co., Ltd., Quebec. Gorman's, Ltd., Edmonton and Calgary.

The American Marsh Lines also include Power Pumps, Compressors, Vacuum Pumps, Condensers, Deep Well Engines, Boiler Feed Pumps.

CLINKERS

Clinkers are a nuisance—no one denies that—but some grades of coal will clinker. The best way of handling them is the problem. Shall they be left undisturbed to grow into an immense fixed clinker or shall they be broken up as soon as they form and then gradually pushed down onto the dump and into the ash pit?


ROCKER PLATES FOR AGITATING, CRUSHING AND DISCHARGING ASHES
UNDERFEED RECIPROCATING GRATE BLOCKS
OVERFEED RECIPROCATING GRATE BARS
SAFETY SHEARING PIN THROUGH CONNECTING ROD
SHIFTER LEVER FOR REGULATING COAL FEED
RODS FOR OPERATING RETORT SIDE BARS
RECIPROCATING RETORT SIDE BARS CARRYING GRATES AND ROCKER PLATES
DRIVING SHAFT
VARIABLE SPEED SHAFT
DAMPER FOR REGULATING AIR FOR OVERFEED COMBUSTION
ADJUSTABLE OPENING FOR CONTINUOUS DUMPING
SHAFT FOR ADJUSTING POSITION OF ROCKER PLATES
AIR CHAMBER ACCESSIBLE THROUGH REMOVABLE FRONT PLATE

Years of study and experimentation in stoker design have evolved the Riley "moving grates" as the satisfactory solution to this problem.

Before the clinker gets a chance to spread, the reciprocating retort sides start slicing and pushing the clinker down to the rocker dump where it is continuously crushed and discharged.

And thereby is avoided costly burn-outs from the reverbatory action of flames under large fixed clinkers when left undisturbed.

Let the Machine do the work of breaking up and ejecting the clinkers instead of back-breaking labor on the part of the fireman.

There's more about the labor and fuel saving features of the Riley Underfeed Stoker in our Catalog HR-7. Ask for it.

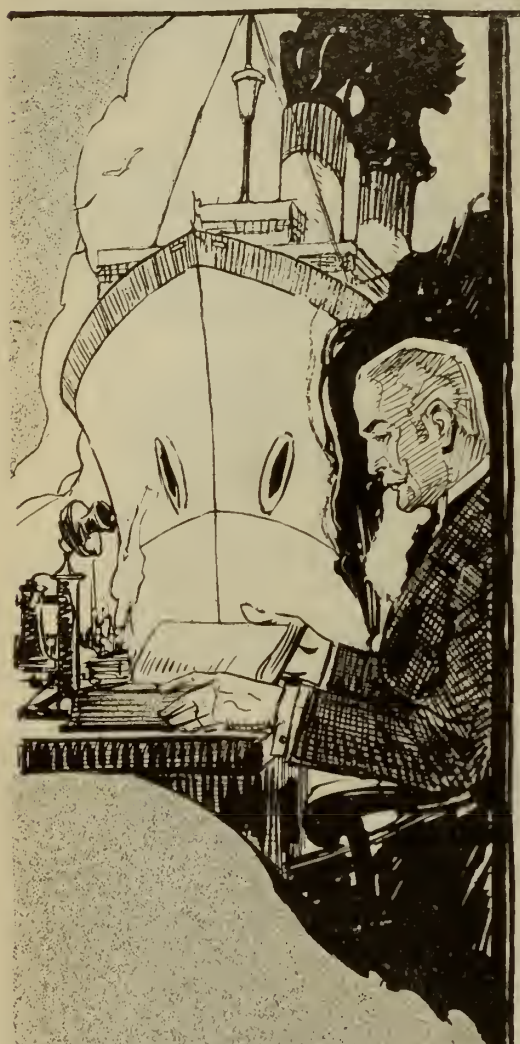
"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS.
Makers of
RILEY UNDERFEED STOKERS
BOSTON NEW YORK CINCINNATI PHILADELPHIA CHICAGO PITTSBURGH ST PAUL

TRADE MARK Rx REGISTERED

MURPHY IRON WORKS
DETROIT, MICH.
Makers of
MURPHY AUTOMATIC FURNACES
BUFFALO CLEVELAND DENVER

When a Wise Shipper Charters a Ship, He Looks Up Lloyds Register



He wants to know more than actual tonnage. The condition of the ship, her record, the reputation of her owner and skipper are all factors in his choice of a carrier.

His mental attitude is the same as that of the Scientific Space Selector who wants to know more about publications than a mere statement of "Net Paid Circulation."

The wise Space-Buyer keeps his copy of "Scientific Space Selection" handy and digs deep into the facts set forth in A. B. C. reports so that he can obtain authentic data on where the publication goes, and to whom it goes.

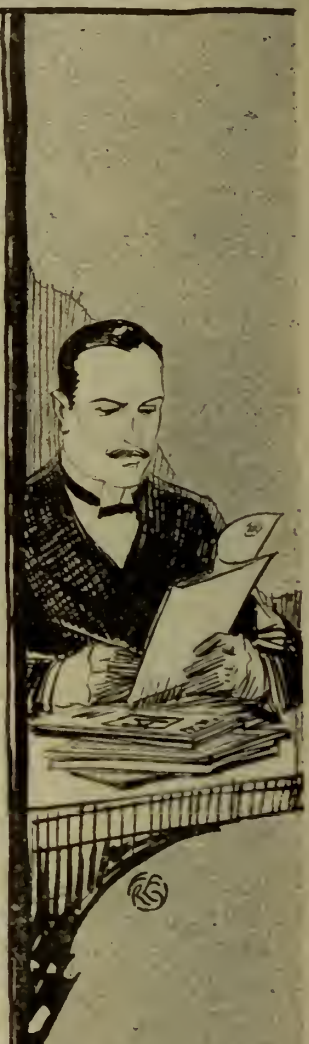
He also wants to know about the influence, stability and character of the publication in which he is going to buy white space.

All these facts can be obtained from A. B. C. reports. You'll find a carefully audited statement about circulation on the first page and, if you read pages two, three and four, you'll be able to visualize the character of the publication and to answer the question, "Will this medium help to sell my goods?"

The capacity for taking infinite pains becomes, every year, more applicable to Space Buying. Exaggerated claims, misleading figures, general statements are looked upon with critical eyes. Deductive reasoning dominates space selection, as it does every other business proposition.

That is why A. B. C. reports represent the back bone of space buying. They are correct, informative, and clearly set forth

— but to reap the full benefit of A. B. C. reports they must be studied for more than the mere statement of "Net Paid Circulation."



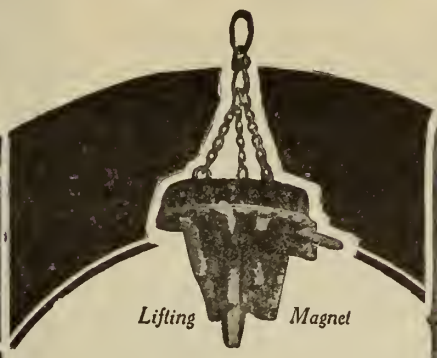
Be sure to get your copy of "Scientific Space Selection," the new A. B. C. book. A guide to every advertiser, space-buyer and publisher who is interested in the sale or purchase of white space. *Price, two dollars and a half.*

Audit Bureau of Circulations

202 South State Street Chicago · 347 Fifth Avenue New York

CUTLER-HAMMER

Automatic Starter



Lifting Magnet

Compensator

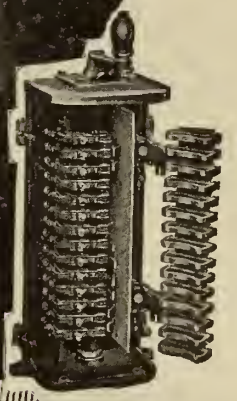
Magnet and Control Devices

¶ Cutler-Hammer Lifting Magnets and Magnetic Separators have proved of exceptional value in the mining field, in steel mills and in many other industries for lifting and separating metals. The Magnetic Clutch and electrically operated Brake, used primarily in steel and rubber mills and for crane control repectively, are widely applicable to many industries where the gradual engagement or adequate braking of a load is desirable.

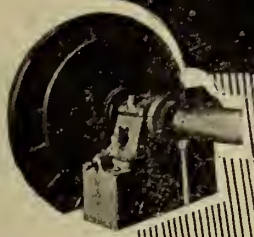
¶ In electric controlling devices of all kinds Cutler-Hammer is the recognized standard of dependability, whether for fine speed adjustment of a machine, extremely close voltage regulation, the wonderful light dimming and colour effects in a modern theatre, or the automatic control of heavy loads or other special operations.

¶ Details and recommendations of suitable Cutler-Hammer apparatus for your control problems are available at our branches.

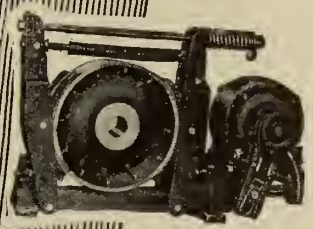
Theatre Dimmer



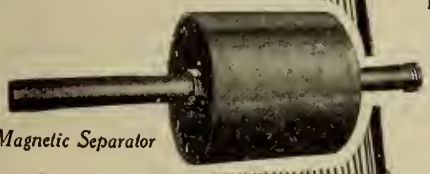
Drum Controller



Magnetic Clutch



Motor Operated Brake



Magnetic Separator

Northern Electric Company

LIMITED

Montreal Quebec Toronto London Regina Edmonton
Halifax Ottawa Hamilton Windsor Winnipeg Calgary Vancouver

Chimney Repair Work

Does your chimney need repairing? Experienced chimney foreman and expert repair man is open for engagements. Put your problems up to me. Rates reasonable.
Box 203, Power House.

EQUIPMENT

WE BUY IDLE EQUIPMENT OR MACHinery; call or write, mentioning Power House. H. W. Petrie, Ltd. Toronto.

READER'S NOTICE

Regarding

CHANGE OF ADDRESS

A REQUEST FOR CHANGE OF ADDRESS must reach us at least thirty days before the date of the issue with which it is to take effect. Duplicate copies cannot be sent to replace those undelivered through failure to send this advance notice. Be sure to give your old address as well as the new one.

If you want something unusual

and it isn't advertised here, the logical thing would be to advertise for it. You'll find that a small ad. in the Classified Advertising Section will save you a great deal of time in locating men or machinery. Look over these pages and if you don't see what you want, send us your copy to-day for next month's issue.

POWER HOUSE

Classified Advertising Section

143-153 University Avenue
TORONTO

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

FOR SALE

1 H.R.T. BOILER—72-IN. x 16-FT. SHAKER grates and stack, complete; 125 lbs.
1 H.R.T. BOILER—60-IN. x 14-FT., 120 pounds. Apply, mentioning Power House to Wilson-McGovern, Ltd., Lumsden Bldg. Toronto.

THE JOHN INGLIS CO., LTD., ENGINeers and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention Power House.

THE MILNES COAL CO., LTD., 85 KING St. East, Toronto; soft coal (any grade) hard coal, any size, in carlots. Write for prices, mentioning Power House.

STEAM ENGINES, BOILERS, HEATERS, tanks, stacks, pumps and condensers, transmission and elevating machinery, safes, vaults and vault doors; catalogue and specifications sent on request. Apply, mentioning "Power House," to Goldie & McCulloch Co., Ltd., Galt, Ont. (pfh)

LIGHTING PLANT FOR SALE—1200 UNit Lallcy light farm-lighting plant; new; complcte with Willard storage batteries, 32 volt; suitable for summer home; lighting at half price; for immediate cash salc, $400. Apply, mentioning Power House, Smith & McLaughlin, 259 Colborne St., Brantford, Ont.

FOR SALE—A NUMBER OF SECOND-HAND machine tools in excellent condition; these may be inspected at our works. Apply, meationtioning Power House, The Wnterous Engine Works, Co., Limited, Brantford, Ont.

ELECTRIC MOTORS—NEW AND SECONDhand; electric machinery repaired; we nlso buy motors. Apply, mentioning Power House, The Electrical Engineering Co., 122 Wellington West, Toronto.

SAWMILL MACHINERY MANUFACTURED by sawmill machinery specialists. Apply, mentioning Power House, The E. Long Manufacturing Co., Limited, Orillin.

FOR SALE—ONE 16-INCH, ONE 24-INCH Sheldon exhaust fans, practically new. Apply, Box 205, Power House.

MACHINERY FOR RENTAL — WE WILL rent by the month motors, hoists or contractors' plant of any description. Apply, mentioning Power House, H. W. Petrie, Limited, Toronto.

ALTERNATING MOTORS AND ELECTRICAL machinery; all sizes for power and light. Apply, mentioning Power House, Jones-Moore Electric Company, Toronto.

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS
An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.
E. H. KELLOGG & CO.,
New York, U.S.A.

SITUATIONS WANTED—MALE

STATIONARY ENGINEER (2ND CLASS)—would appreciate steady position in country; references A1. Apply, mentioning Power House, to Box 218, Globe.

MECHANICAL ENGINEER, 29, FIRST-CLASS stationary engineer's license for Ontario, 10 years' power plant experience, saw-mill and paper mill; specialist in making repairs and operating plant economically, desires permanent position with large saw-mill or paper mill, preferably in New Ontario. Apply to Box 202, Power House.

STATIONERY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers. Corliss and all classes of stationary engines, compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St., Toronto.

POSITION WANTED BY AN EXPERIENCED refrigerator engineer, also competent in ice making and electricity. Address, D. M. J., Power House, Toronto. (p1h)204

MONCRIEFF'S

Moncrieff's "Unific" is not a cheap glass. But because it outlnsts mnny ordinary glasses the "Unific" is economical. British Made.

"UNIFIC" WATER GAUGE

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

GLASSES

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

How to Test Advertising

THE man who doubts the power of advertising belongs in the same class with the man who refuses to believe that the world is round simply because he can't get off somewhere at a distance and see its roundness for himself.

The merchant who fears to attempt advertising because he figures it as an "expense" is blind to his own interests. I personally know several men who, because they once tried advertising to the extent of a cheaply printed hand-bill and didn't find it necessary next morning to call on the police to keep the crowds of eager buyers from swamping their store, loudly and solemnly aver that "advertising doesn't pay."

Advertising *does* pay.

The most successful merchants are the merchants who believe most thoroughly in advertising and who practice their belief.

But advertising, in order to pay, has got to be *intelligent* advertising.

The day of hashed-over superlatives — "best goods," "lowest prices," "best stock in town," "greatest bargains ever heard of," and so on—has passed.

People have learned to distinguish the *truthful* advertiser from the blatant behind-the-times storekeeper who believes that, so long as *he* claims to have the best goods on earth, or under the earth, or within wireless distance of the earth, people will break their necks trying to get to his counters in the forefront of the crowd.

Put some *brains* into your advertising.

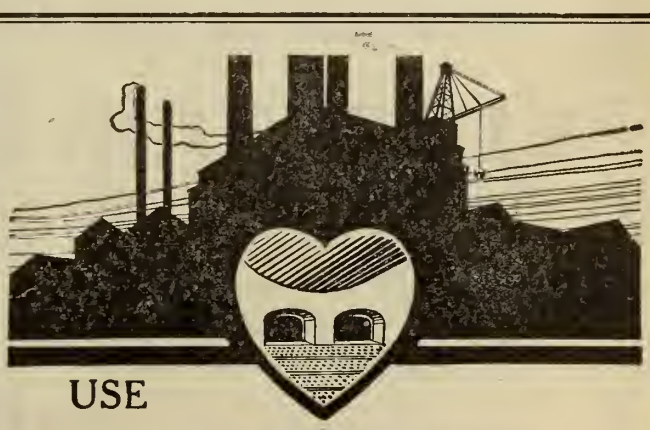
Don't let the office boy write your announcements in between his other duties.

Don't doubt the business-getting and business-building power of intelligent and informative publicity — and you will find that advertising *does* pay.

—Jerome P. Fleishman.

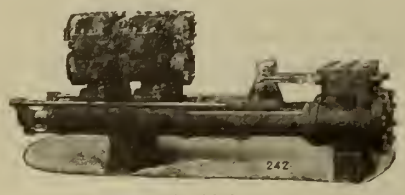
Godfrey Conveyor Co.
127-147 Thirteenth Street, ELKHART, Ind., U.S.A.
Originators, Patentees and Manufacturers of
CONVEYORS
Operating Gravity-Filled Bottom
Dump Bucket by Monorail or Cableway.
Canadian Office:
M. A. KENNEDY, LIMITED
TORONTO, CANADA
106-110 Richmond St. West Phone Adelaide 7511

Tuck's Genuine Packings
Asbestos and Others for High Pressure,
Steam, Hydraulic and Other Purposes.
Trial Orders Solicited—Our Packings Do the Rest
Insist Upon Having the TRADE Packing Bearing Our MARK
TUCK & COMPANY, LIMITED
London Liverpool Cardiff, Etc.
Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.
Stocks carried in all sizes TEL. No. MAIN 2387


USE
BETSON'S
REG. U.S. PAT. OFF. TRADE MARK
PLASTIC FIRE BRICK
IN THE HEART OF YOUR PLANT
Build permanent, properly flared, one-piece boiler arches and walls without any bricks to fall out.
Betson's Plastic Fire Brick eliminates frequent shut-downs for repairs, prevents inleakage of cold air. Any man can build one-piece arches and make perfect furnace linings with Betson's Plastic Fire Brick.
Write for informative booklet
for boiler room use.
Betson Plastic Fire Brick Co., Inc.
P.O. Box 386-6, 13 Astor Place, N.Y.
Canadian Distributors: INTERNATIONAL CHEMICAL CO.
44-6 Lombard Street, Toronto, Ont., Canada
If it isn't BETSON'S it isn't Plastic Fire Brick

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

All Made to Gauge. All parts interchangeable. Give us opportunity to figure on your pumping requirements.



Cut 7242

We have full line of Patterns for direct acting steam pumps and belted or direct connected power pumps.

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

How do you get that way?

EASY!

"By using the right thing in the right place, and at the right time. I have no packing troubles as I am using *Ambest Metallic Packing*.—All sizes in a can. My furnaces are lined with PLIBRICO, so I have no worries on that score, and as for my Shafting, why, BULL Bearing Alloy takes care of that."

Sales Agents for Plibrico Jointless Firebrick.

Beveridge Supply Co., Limited
MONTREAL

KEEP YOUR BOILERS CLEAN
TO SAVE FUEL

⅛-inch Deposit on Tubes Increases Coal Consumption 30%
¼-inch Deposit on Tubes Increases Coal Consumption 66%
½-inch Deposit on Tubes Increases Coal Consumption 150%

MILLER'S BOILER CLEANING EXTRACT

Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

TRY A CASK!

R. C. Miller Oil & Supply Company
38-40 Youville Square, MONTREAL

It Brings Returns

in money saved, in coal saved, in time saved, to invest in

PLIBRICO JOINTLESS FURNACE LINING

A furnace lining full of joints means loss of money through loss of heat and rapid deterioration. There are NO joints in a PLIBRICO lining, therefore no loss of heat—no coal waste—and deterioration cannot start.

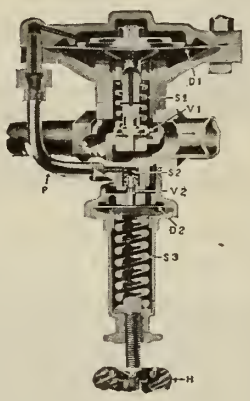
A PLIBRICO lining is quickly and easily installed, a saving in time. Therefore PLIBRICO is a big-paying investment.

Shipped in steel containers of distinctive appearance as shown at the right.

Warehouse stocks in Montreal, Toronto, Winnipeg, Vancouver and Calgary ready for immediate delivery.

Ask for book L-12 on Furnace Building.

FISHER
TRADE MARK REGISTERED



LOW PRESSURE CAN'T BUILD UP

If you manufacture a product requiring curing, drying, bleaching, dyeing, vulcanizing, evaporating, or any other process dependent upon a uniform temperature or pressure you will certainly be interested in

FISHER PRESSURE REGULATOR
Series 90

It will accurately and consistently deliver any desired reduced pressure to apparatus.

It will also shut off absolutely tight when low pressure is interrupted. Pressure cannot build up on the low pressure side.
Like all other Fisher specialties this valve is distinguished by excellence of material and workmanship.

Actual service in thousands of plants throughout Canada has proven Fisher Power Plant Specialties to be long-lasting and accurate in the most trying and delicate operations.

Ask your dealer or jobber for full information about the Fisher line. Or write for "POWER PLANT SPECIALTIES." It is full of interesting information. We will gladly send you a copy. Write today.

The Fisher Governor Company
922 Fisher Avenue Marshalltown, Iowa.

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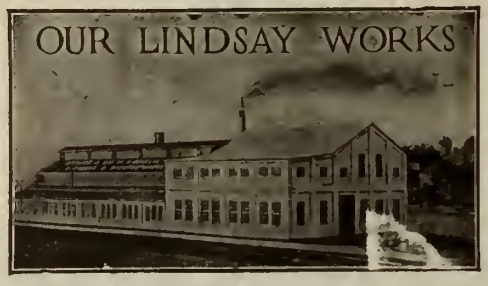
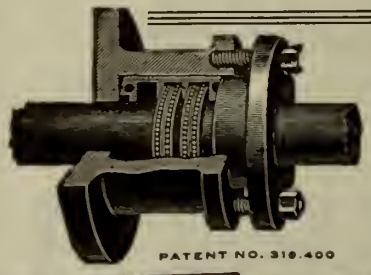
Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario



PATENT NO. 319,400

PAT. NO.	500,899	PAT. NO.	829,118
" "	534,104	" "	830,530
" "	602,328	" "	858,103
" "	654,541	" "	876,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,066
" "	775 193	" "	906,108
" "	775,194	" "	934,629
" "	791,300	" "	979,206
" "	806,699	" "	1000,75

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HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

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PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO.
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Eastern Office: 71 Fulton St., New York.

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In buying NEW and USED Power Plant Equipment it is much to your advantage to say

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Quality--Service--Satisfaction; that is what we guarantee on

Tanks—any size, any capacity up to 2,450 gals.
Vertical Boilers—1 to 75 H. P.
Horizontal Boilers—6 to 200 H. P.
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Automatic Engines—15 to 450 H.P.
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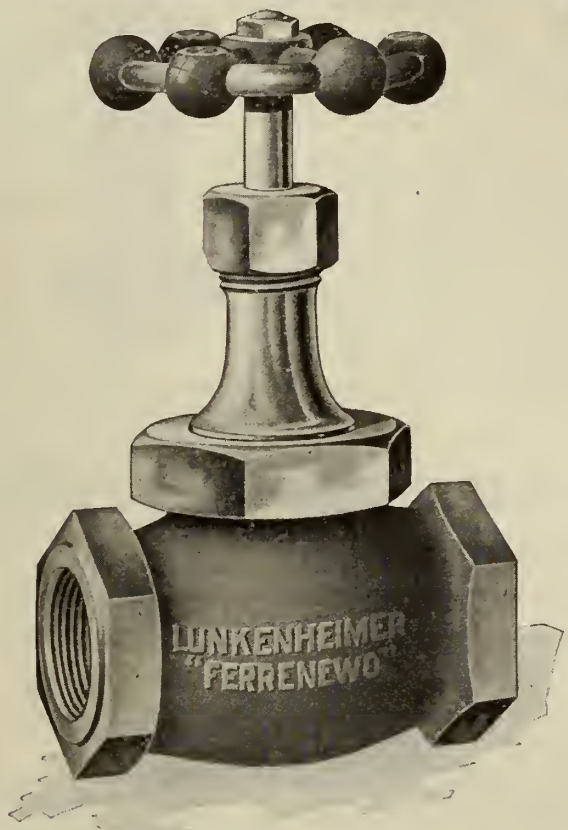
Write for full particulars.

H. W. Petrie Limited
Toronto and Hamilton

LUNKENHEIMER
"Ferrenewo" Valves



"FERRENEWO" Valves are *economy* valves, proved so by their record of years in service. Low initial cost, wear resisting materials and the ease of renewal of all the parts should necessity require, makes them highly desirable for piping equipment where the pressure does not exceed 150 pounds.

LUNKENHEIMER "Valve-iron" from which "FERRENEWO" Valve bodies are made is an especially alloyed and processed Ferrous Composition. The renewable *seatring* and *disc* are made of LUNKENHEIMER "Valve-nickel," while the bonnet, stem and bonnet ring are made of bronze compositions formulated especially for the duty each part performs.

The "FERRENEWO" material combination and unique design, coupled with the LUNKENHEIMER method of manufacture insures successful results under the wide range of operating conditions for which "FERRENEWO" Valves are adapted.

LUNKENHEIMER Distributors situated in every commercial center carry "FERRENEWO" Valves in stock for immediate delivery.

To standardize on "FERRENEWO" Valves is
to *economize* in valve cost and maintenance.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
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OF CATALOG BEARS
No 58
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LUNKENHEIMER
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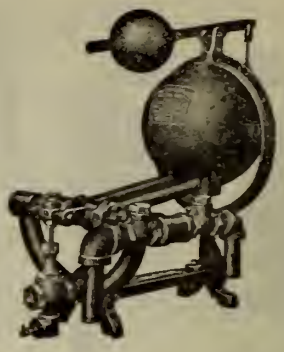
MASON
POWER PLANT DEVICES

Mason Standard Iron Body Reducing Valve



New Bundy Steam Trap

Mason No. 55 Pump Pressure Regulator

Choose Equipment that is Really Serviceable

What you gain in length of service alone would be ample reason for choosing Mason Appliances. But Mason Power Plant Devices combine unfailing accuracy with long life. You can rely upon them in the most critical positions.

Mason Engineers Will Help You

When you buy Mason Power Plant Devices you get the advantage of MASON SERVICE. This service guarantees that you get the line best adapted to the purpose, with a view to greatest economy and greatest efficiency.

Let us know your problems. We have the answer.

THE MASON REGULATOR & ENGINEERING COMPANY, LIMITED

135-153 DAGENAIS ST., MONTREAL Agencies in Principal Canadian Cities

KERR
"New KEYSTONE" (Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

JONES "A-C" STOKERS

It's The Cost of Stoker *Service* That Counts

PLANTS that have installed Jones "A-C" Stokers have found that the most expensive stoker is the hand stoker. Why? Because the cost of hand firing per ton of coal fired is excessive and beyond reason. Yet there is no first cost to hand firing.

Bear this in mind in selecting a mechanical stoker to overcome the exorbitant expense of hand firing. Forget first cost and choose the stoker that costs least per ton of coal fired.

The records of Jones equipped plants prove that there are a number of sound reasons why you buy your stoker service cheaper when you choose the Jones "A-C."

It will save MORE coal—by burning a wide range of poor coals with high efficiency. The Jones under-feed principle insures that.

It will give greater boiler capacity—by carrying heavy overloads continuously.

It will save in maintenance costs, for it is the simplest, most rugged high-duty stoker.

The new "A-C" catalog will convince you that stoker service costs least per year when you operate the Jones "A-C." Where shall we mail your copy?

The Under-Feed Stoker Co. of Canada, Ltd.

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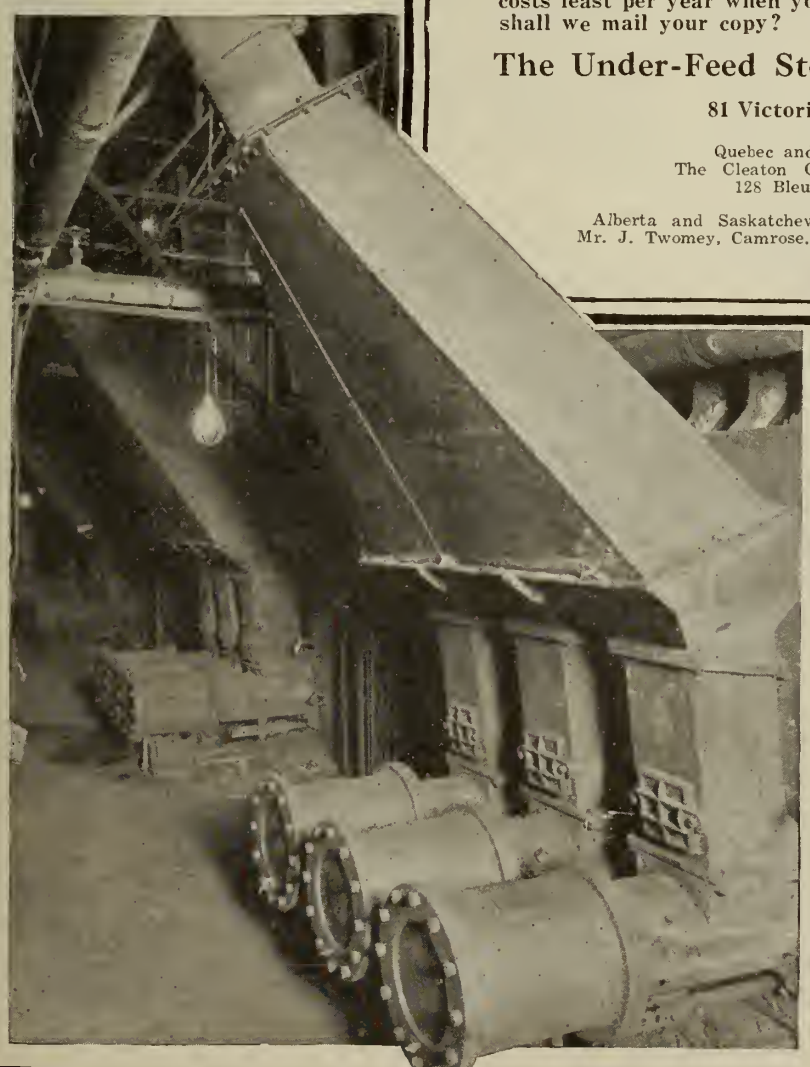
Quebec and the Maritime Provinces:
The Cleaton Company (Canada) Ltd., 403 Southam Bldg.
128 Bleury Street, Montreal, Que.

Alberta and Saskatchewan:
Mr. J. Twomey, Camrose, Alta.

British Columbia:
E. A. Earle, Limited,
729 Hastings St. W., Vancouver, B.C.

Jones "A-C" Stokers in a Prominent Paper Mill.



The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized as The Under-Feed Stoker Co. of Canada, Ltd., and the reorganization makes available for Canadian power users the extensive engineering resources of The Under-Feed Stoker Co. of America.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

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Penberthy Injector Co., Windsor, Ont.

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American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto.
Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Rochester, N.Y.

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Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

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York Mfg. Co., York, Pa.

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Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York, N.Y
Garlock Packing Co., Hamilton, Ont
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Pratt & Cady Co., Inc., Hartford, Conn.

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Northern Electric Co., Ltd., Montreal.

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Northern Electric Co., Ltd., Montreal.

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Beveridge Supply Co., Montreal.

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Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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BELTING, CONVEYOR
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Waterous Engine Works Co., Brantford.

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Gutta Percha & Rubber Co., Limited.

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Dominion Belting Co., Hamilton, Ont.
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BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que
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BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited
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BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

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Mackinnon Steel Co., Ltd., Sherbrooke Q.
Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc. Montreal Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

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Jointless Fire Brick Co., Chicago, Ill.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

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Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

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R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

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Crane Ltd., Montreal
W. R Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

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Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.

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Beveridge Supply Co., Montreal.

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Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
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Crane's Limited, Montreal.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.

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Mueller Mfg. Co., Ltd., The.

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Mueller Mfg. Co., Ltd., The.

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H. Mueller Mfg. Co., Ltd., Sarnia.

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Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

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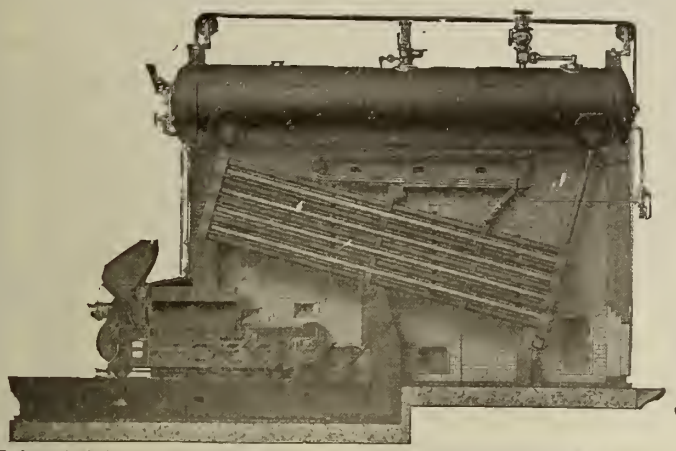
"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
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Coal-Handling Machinery
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and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

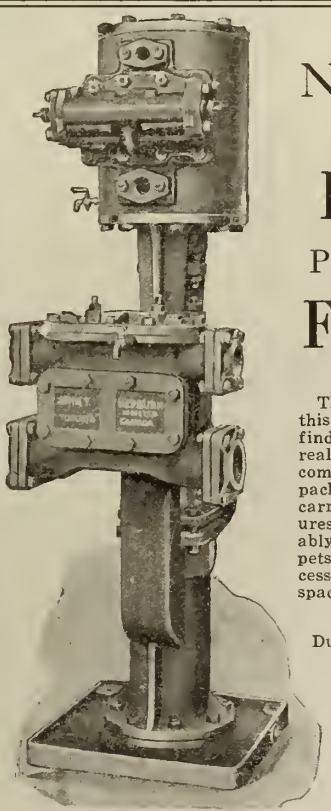
Low Cost Coal Storage with "LABRIDE" Equipment

If you are unloading coal by hand, the "LABRIDE" Equipment will save you from 70 to 95 per cent. of your coal handling cost. This equipment consists of a moving bridge traveling lengthwise of the storage space and a bucket trolley traveling crosswise on the bridge,—thus every square foot of storage space is covered with a minimum of movements and time. The "LABRIDE" Equipment is the fastest, most efficient and economical method known in coal handling today. Capacity varies from 60 to 90 tons per hour.

Write or wire for information.

Lakeside Bridge & Steel Co.

159 VillardAvenue, North Milwaukee, Wis.



NO EXCUSES
With the
HEPBURN
Patent Vertical Ram
FEED PUMP

There are no excuses attached to this Hepburn Patent Pump. You'll find that out if you give it some real work to do. It is a sturdy, compactly constructed, outside packed type for Feeding Boilers carrying the highest steam pressures. The construction is remarkably simple and eliminates all tappets and levers. Every part is accessible, and it takes little floor space in the Power House.

Duplex Pumps, Vertical Engines, Compressors, Hand and Electric Overhead Cranes for Power House Service are also products of the Hepburn plant.

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET, TORONTO, CANADA

R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOSETS
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD PIPE BENDING CO.
The Tube Pipe Bending Co., Toronto, Ont.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto., Ont.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Beveridge Supply Co., Montreal.
Shell Bar Boiler Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

FIRE BRICK
Beveridge Supply Co., Montreal
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK, PLASTIC
Beveridge Supply Co., Montreal
Betson Plastic Fire Brick Co., Rome, N.Y.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.

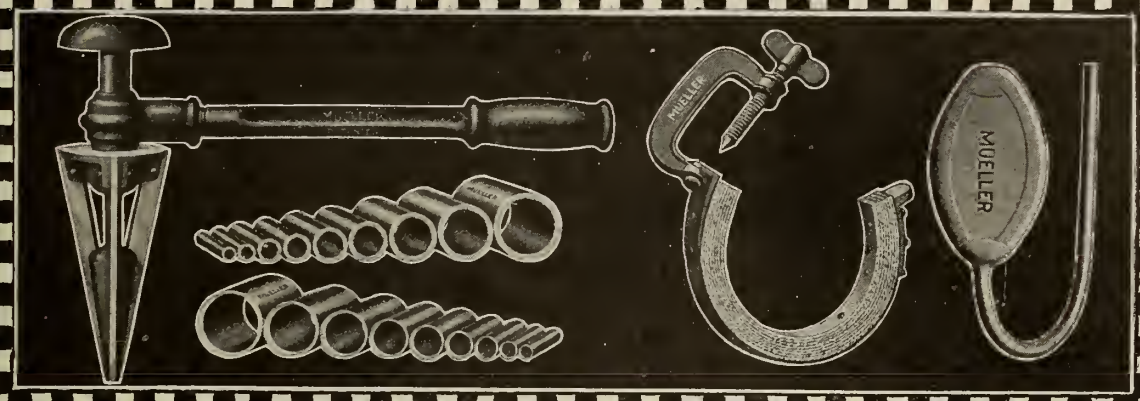
FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Page-Hersey Tubes, Ltd., Toronto, Ont.



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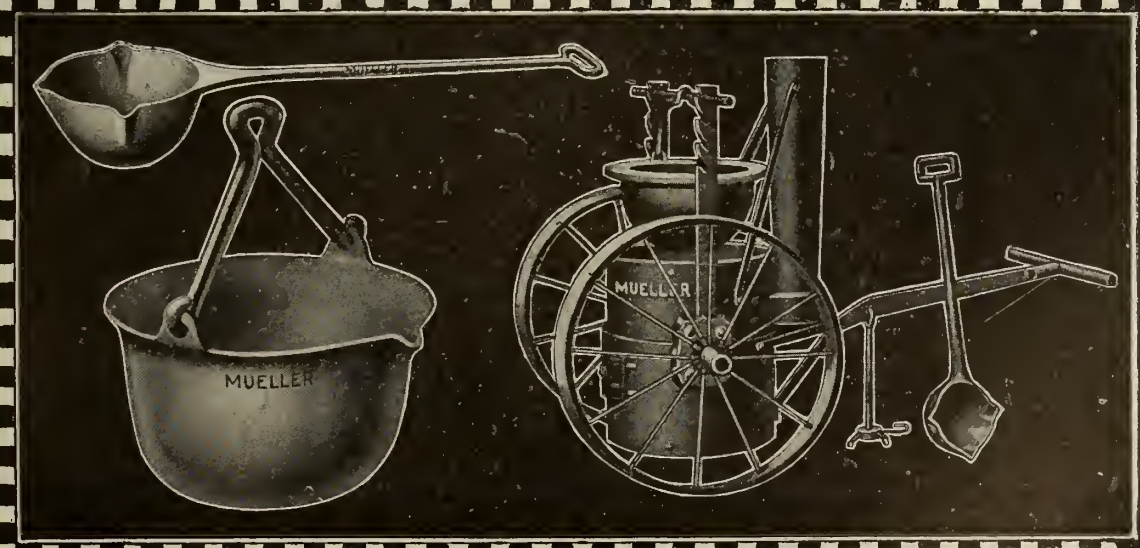

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

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Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

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Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
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Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co.

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Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Dominion Flow Meter Co., Toronto.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
John Moncrieff, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Jas. Morrison Brass Mfg. Co., Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GEARS, CUT, WORM, MORTISE
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
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MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

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Babcock & Wilcox, Ltd. Montreal
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
Shell Bar Boico Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

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Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

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Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co. Pa
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal.
York Mfg Co., York, Pa

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.

LEATHER BELTING
W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon

MACHINERY, TRANSMISSION (POWER)
Can. Mead Morrison Co., Ltd., Montreal
B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co, Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

METERS
Dominion Flow Meter Co., Toronto.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Superheater Co., Ltd., The, Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

PACKING ECONOMY

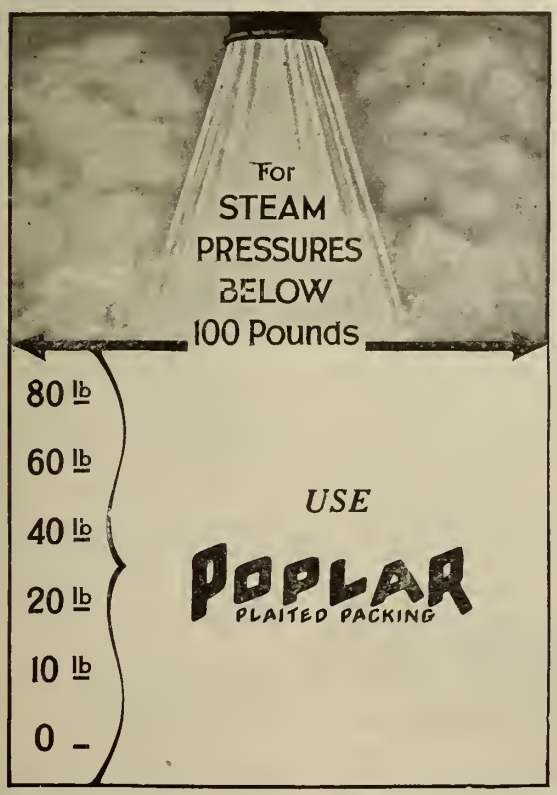
In these days a good engineer carefully studies his operating costs, and as far as packing is concerned he can keep the expense down by using a packing adapted to each particular service.

There is no sense in using an expensive packing under moderate conditions when a less expensive one will answer.

After considerable experimenting we are able to offer you at a very moderate price our "POPLAR" Packing for hydraulic and low steam pressures.

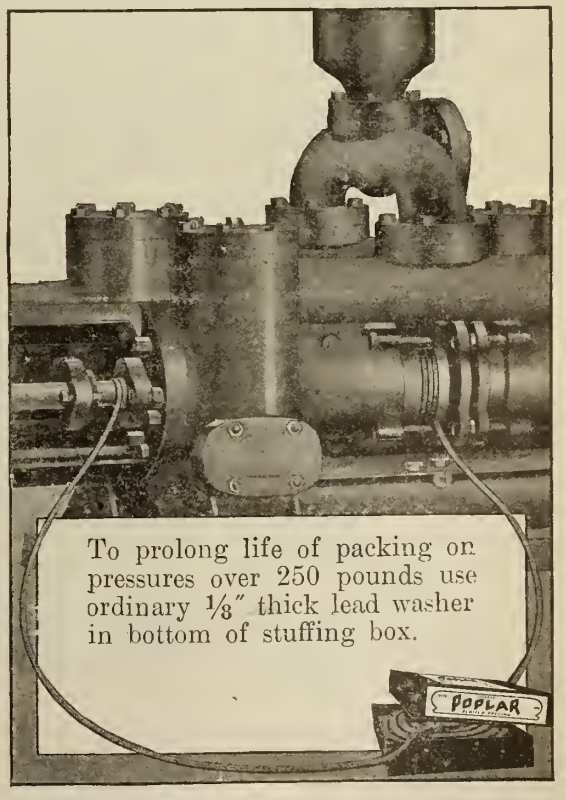
It has high tensile strength, with our unusually thorough method of single strand lubrication of graphite grease, and for the services for which it is designed can be depended upon to give satisfactory service.

"POPLAR" PLAITED PACKING IS PRACTICALLY FRICTIONLESS



WHY NOT GIVE "POPLAR" PACKING A TRIAL?

GREENE, TWEED & Co.
Sole Manufacturers
109 Duane St.
New York


To prolong life of packing on pressures over 250 pounds use ordinary 1/8" thick lead washer in bottom of stuffing box.
POPLAR

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Supply Co., Montreal.
W. J. Brown (Tucks), Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal,

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal,
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.
Darling Bros. Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co. Limited, Toronto

RAGS
Shell Bar Boico Supply, Ltd., Toronto

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Can. H. W. Johns-Manville Co., Toronto.
Dominion Flow Meter Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDEDS CO2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 23 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd. Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

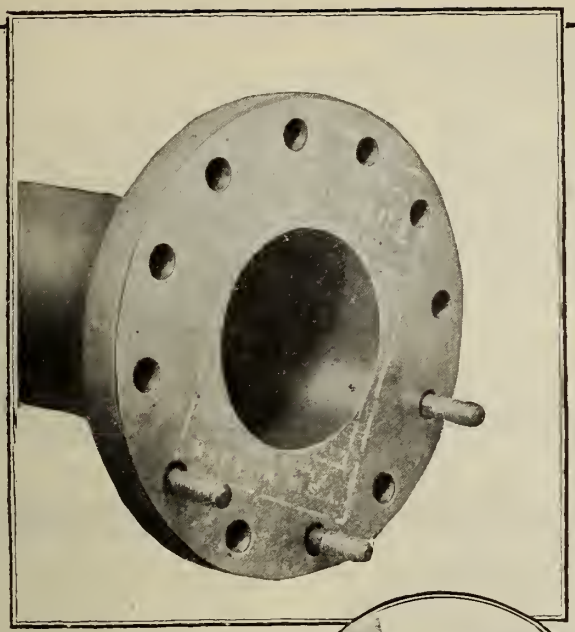
SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

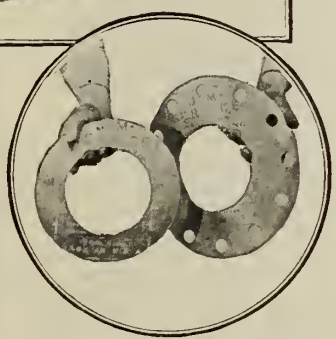
SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

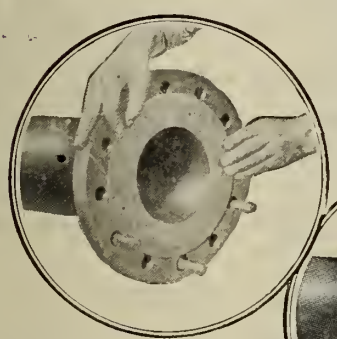
STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.



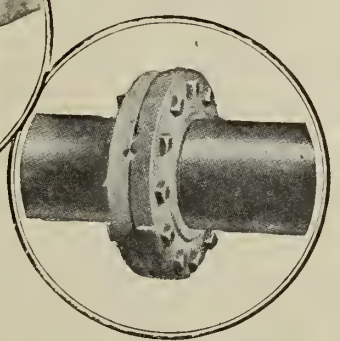
A Ring Gasket cut from Johns-Manville Service Sheet Packing makes a long-lasting tight joint.



Note the difference in size between the Full Gasket and the Ring Gasket. With the same pull on the bolts there would be nearly twice as much pressure per square inch on the Ring Gasket as there would be on a Full Gasket.



A Ring Gasket is easy and quick to cut and apply. There are no bolt holes to fuss with. Cut your Ring Gaskets from Johns-Manville Service Sheet Packing.



If the flanges happen to be irregular or burred, a Ring Gasket is the solution because it doesn't reach out to the damaged edges of the flanges.

Better joints— with smaller gaskets

THE way you cut a gasket often determines the reason for blowouts or tight joints, packing waste or packing economy. You know there are two distinct types of gasket that may be cut from the same sheet for packing pipe and other flanges—these are the full cut type and the ring type both shown in the illustration.

We advocate and recommend the use of the ring type gasket because it makes a tighter, better, more economical joint than the full cut gasket.

Here's why:

1st—The ring gasket allows a greater and more uniform pressure to be brought against the gasket—more pounds per square inch of packing area than is possible with a full gasket.

2nd—Irregularities on the flange or burrs on the outside edges are less likely to prevent a perfect fit with the ring gasket than with the full gasket which reaches to the very outside edge of the flange.

3rd—The ring gasket is more easily made and applied because there are no holes to match up with the bolts or studs which have to pass through a full gasket.

4th—Much less material is required for making ring gaskets.

If you have been guided largely by habit in the use of full gaskets, we suggest that you try ring gaskets and cut them from Johns-Manville Service Sheet No. 60.

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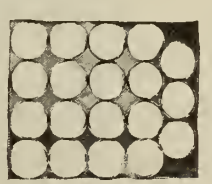
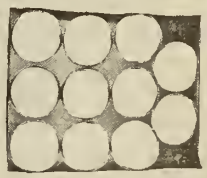


You can cut about 50% more Ring Gaskets than Full Gaskets will do a better job—particularly if they're cut from Johns-Manville Service Sheet Packing



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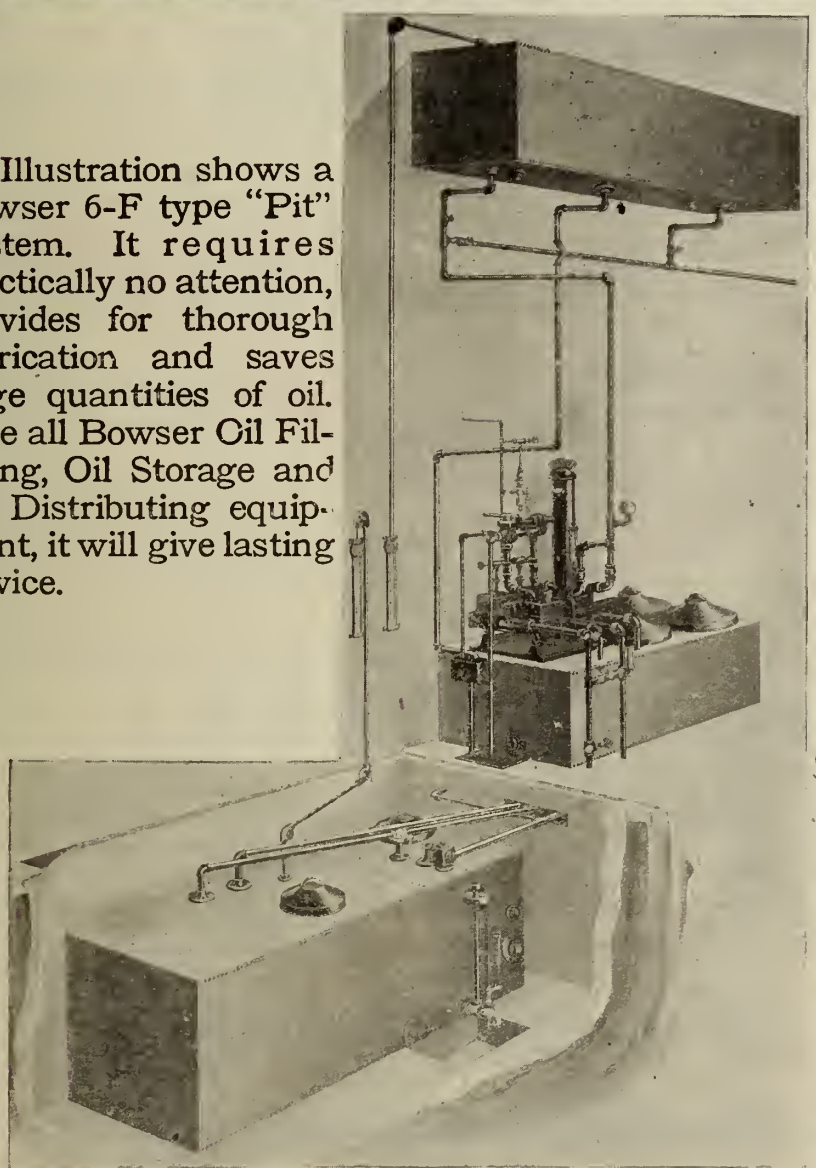

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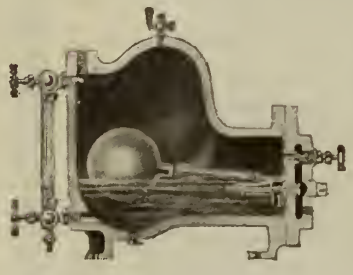

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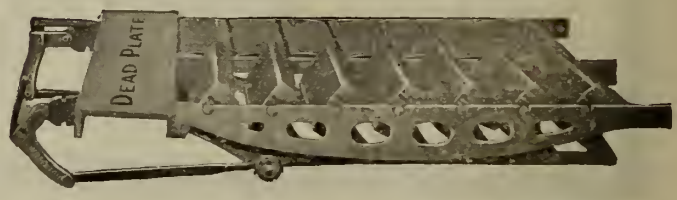

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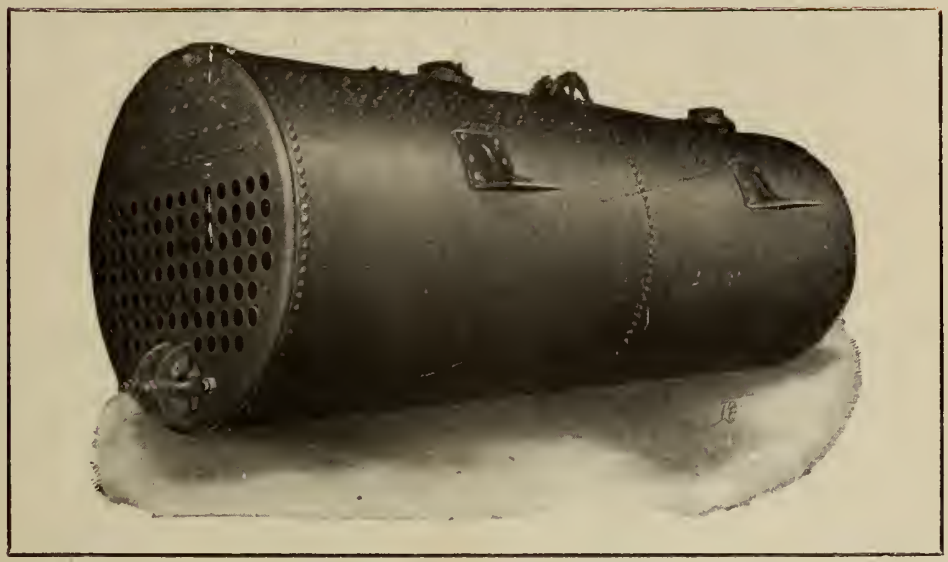

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Inglis Boilers, Tanks and Engines have been accepted as the Standard in Workmanship and Service in Canada for over half-a-century. Always reliable!

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Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 901 Confederation Life Building

Vol. XIV.—No. 14. Publication Office, Toronto—July 20, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Aeroplane View of the Berliner Gramophone Company's Plant, St. Henry, Montreal.

"His Master's Voice" People use Jenkins Valves

Fig. 106
Jenkins Brass Globe Valve
Standard Pattern

Successful manufacturers like the Berliner Gramophone Company realize the importance of dependable equipment at every point and, naturally, "Jenkins" is the choice wherever valves are used.

Many years ago Jenkins Valves were installed in the original Berliner plant and functioned so satisfactorily that the Company insisted upon similar valve equipment in the big new factory addition recently completed.

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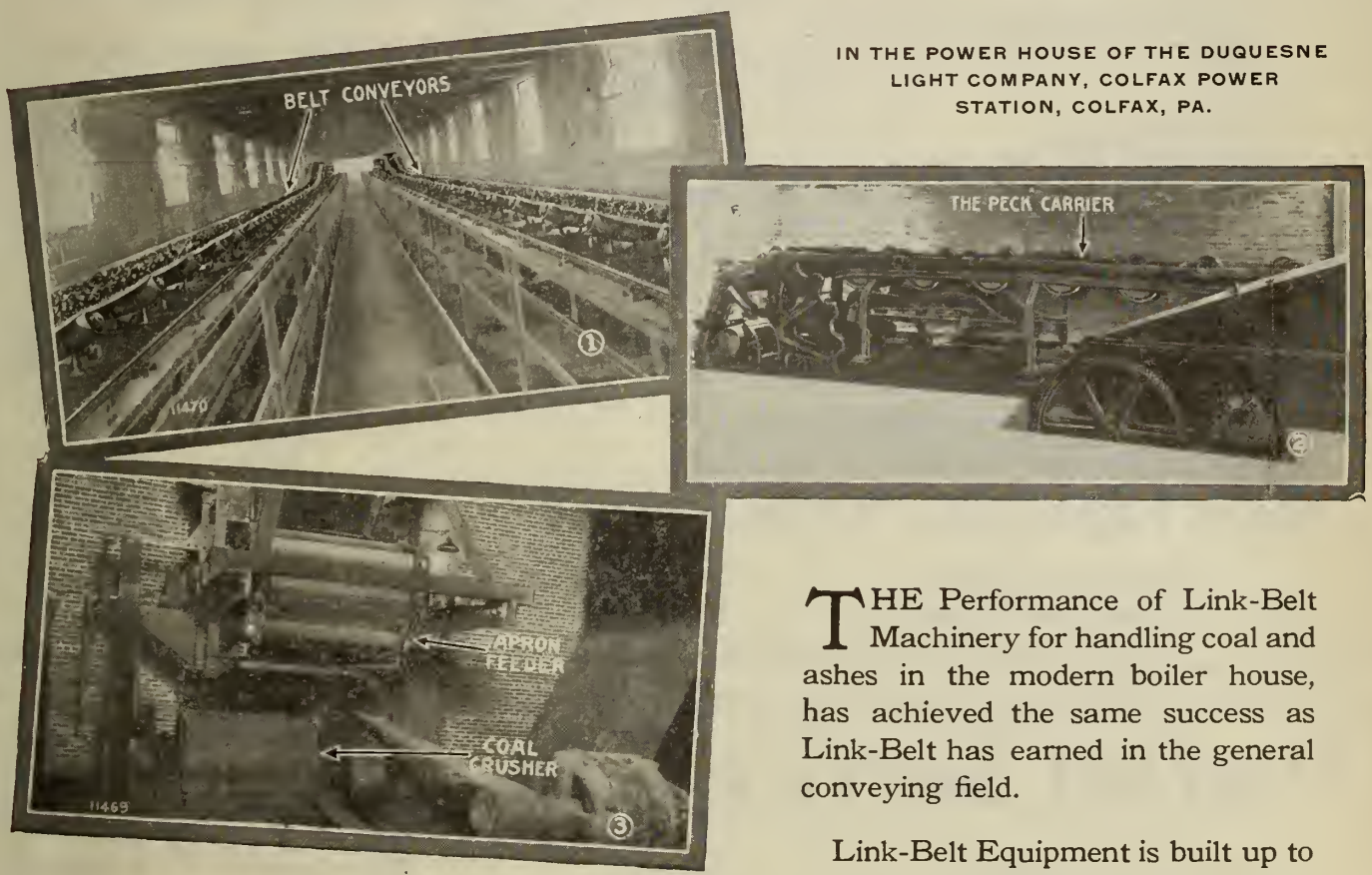

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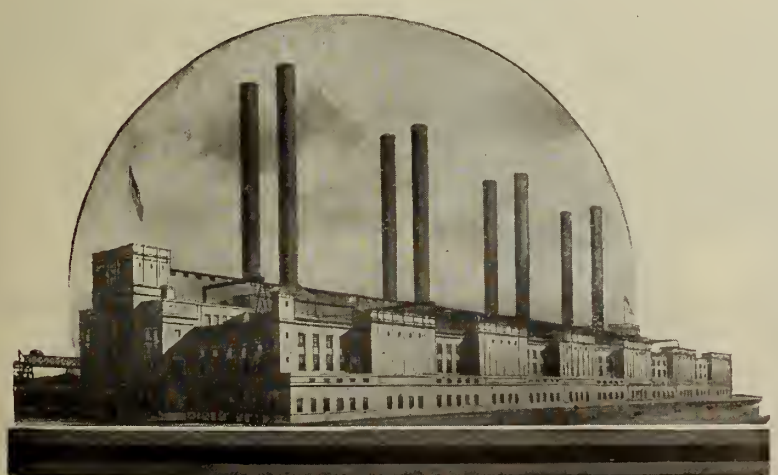
760



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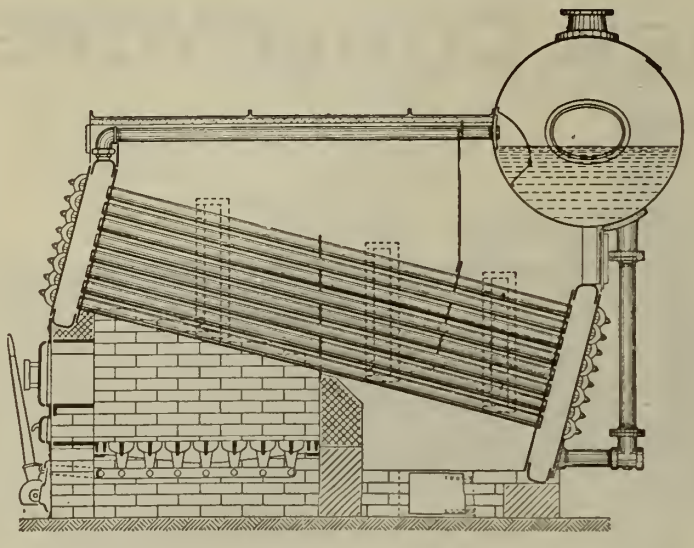

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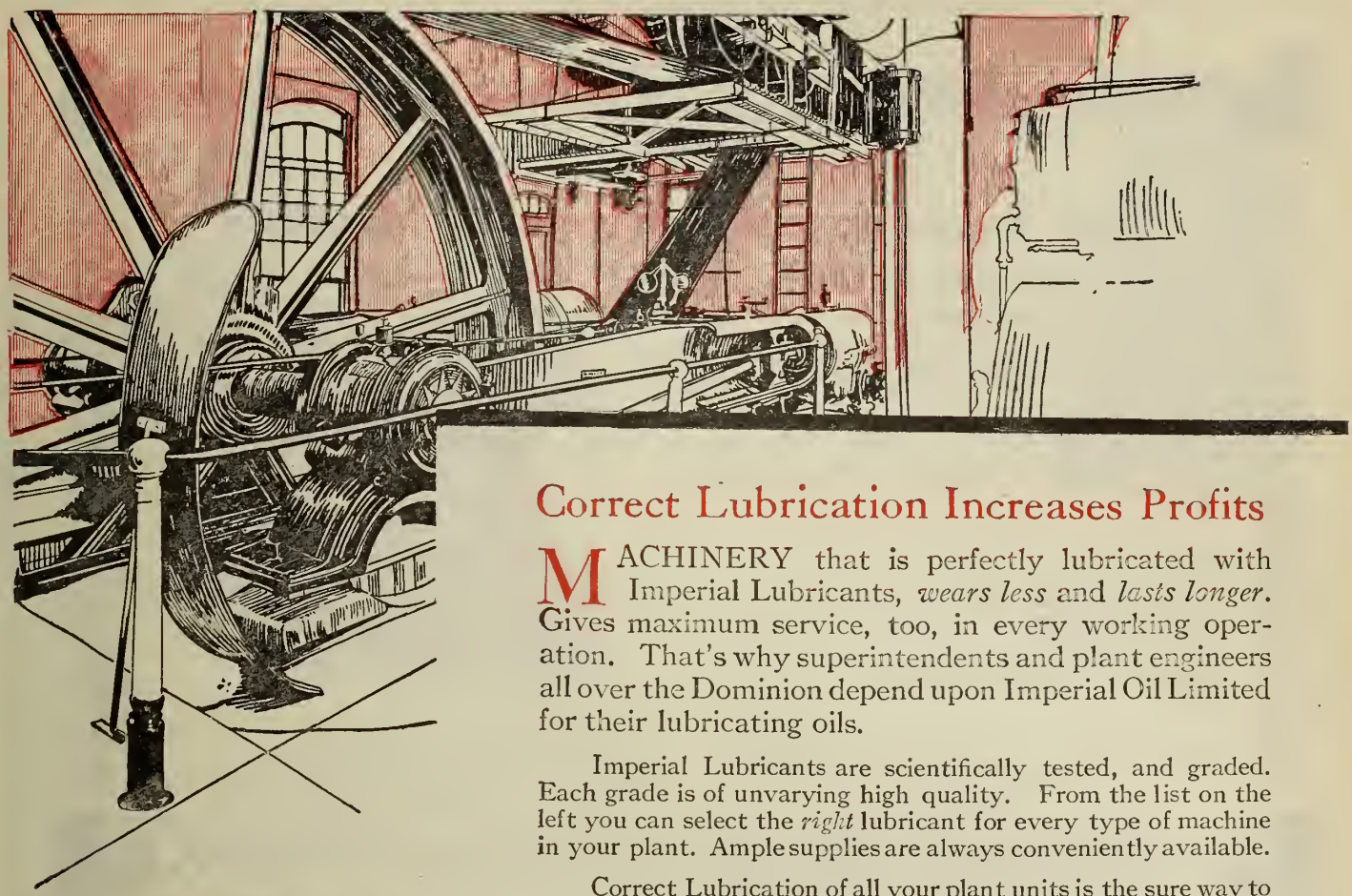

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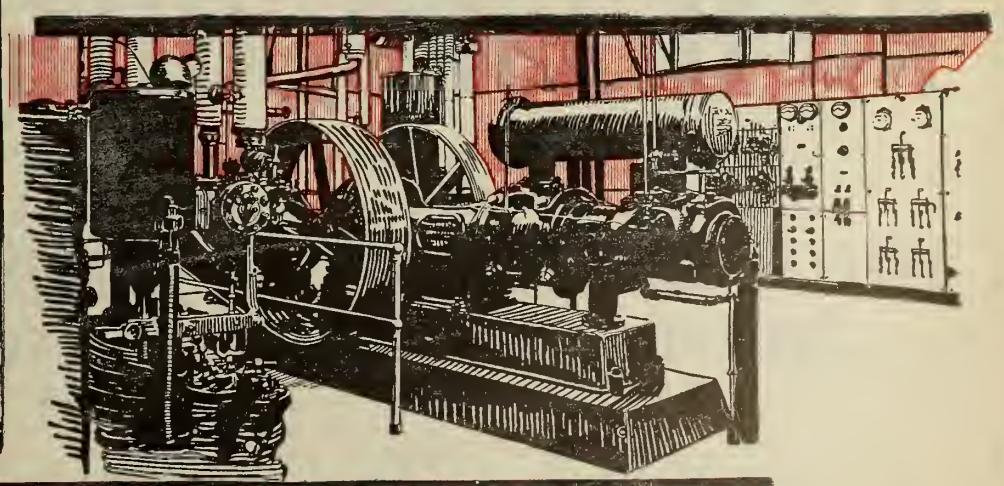

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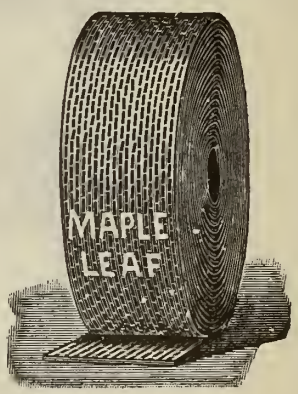
We make only one grade, the best that can be produced.



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Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

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What BOICO will do in one plant it will do in another—**it will do in yours.**

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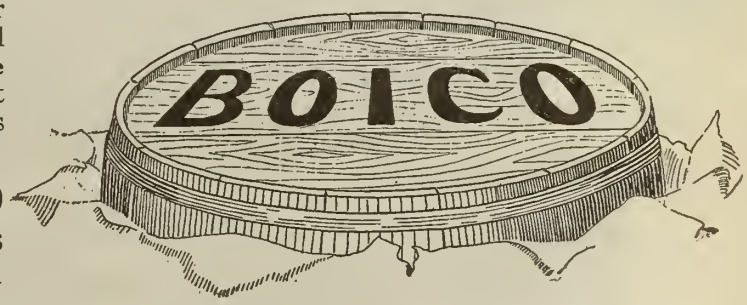

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Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

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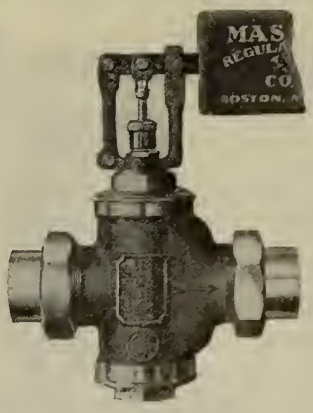

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Plant Production Without Steam Wastes

The Mason Name on regulating appliances is your best protection against production losses. Mason stands for service, reliability and positive action always. Reducing Valves, Pump Pressure Regulators, Steam Traps and Water Filters of every type.
In addition you get the benefit of Mason Service— a service constituting a staff of expert engineers who aid and advise in the economical installation of Mason Equipment.
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After you are satisfied that your boilers and furnaces are in prime condition—look to your method of feeding to STILL FURTHER INCREASE YOUR FUEL SAVINGS.

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Each Copes is designed for the specific conditions governing the boiler—the control valve is neither too large nor too small. This insures maximum efficiency. The use of a high lift valve insures smooth feeding.
The Copes feeds continuously and is absolutely dependable. It contains no springs, floats, auxiliary valve or diaphragms. Get the whole story.

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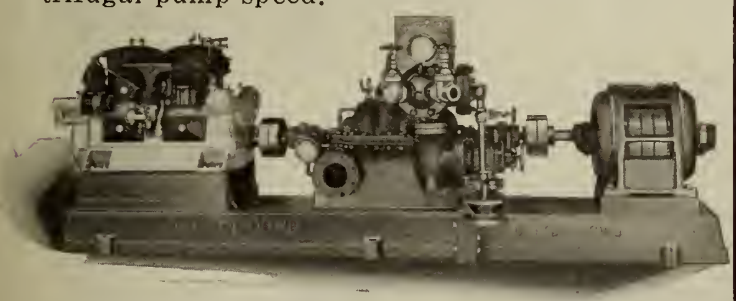
Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Consumes no fuel while standing by, starts instantly, assumes full load and operates at centrifugal pump speed.



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Competent instrument makers, ample equipment for overhauling and testing, indicating, recording and controlling temperature instruments, pyrometers, barometers, etc.

We would be pleased to receive visits and inquiries from those interested either in new equipment or repairs.

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There's a Tycos and Taylor Temperature Instrument for Every Purpose

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7 sizes—6 to 21 inches.

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For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

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Economy!

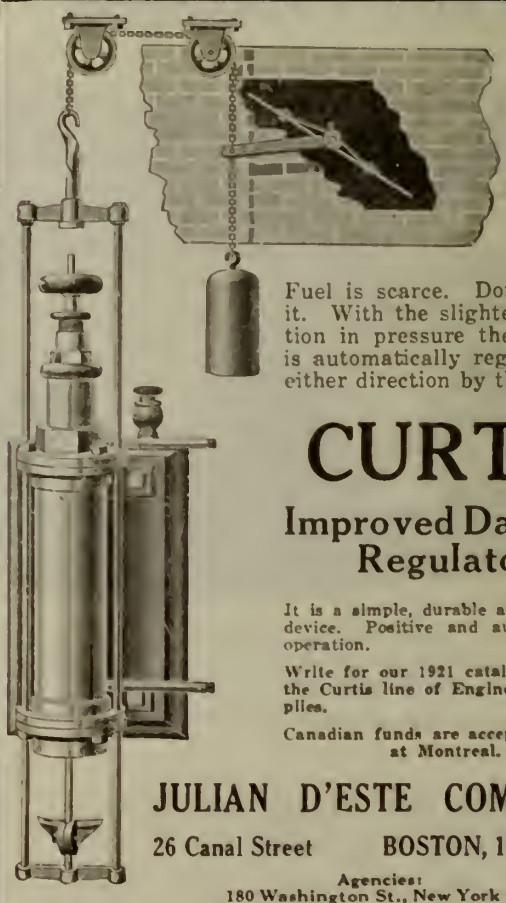
A valve to be economical must give dependable, lasting service.

Homesteads open and close easily. The patent balancing parts insure it against sticking. When the Homestead is fully opened, the two surfaces which are depended upon for tightness are in no way affected by the material passing through. The plug cock provides a straight-way opening which is desirable in all sorts of work but particularly so in high pressure service—also in the handling of thick heavy liquids.

Elimination of waste time and leakages quickly pays for all Homestead valves. You would do well to adopt them without delay.

Homestead Valve Mfg. Company

Homestead, Pa.



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Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

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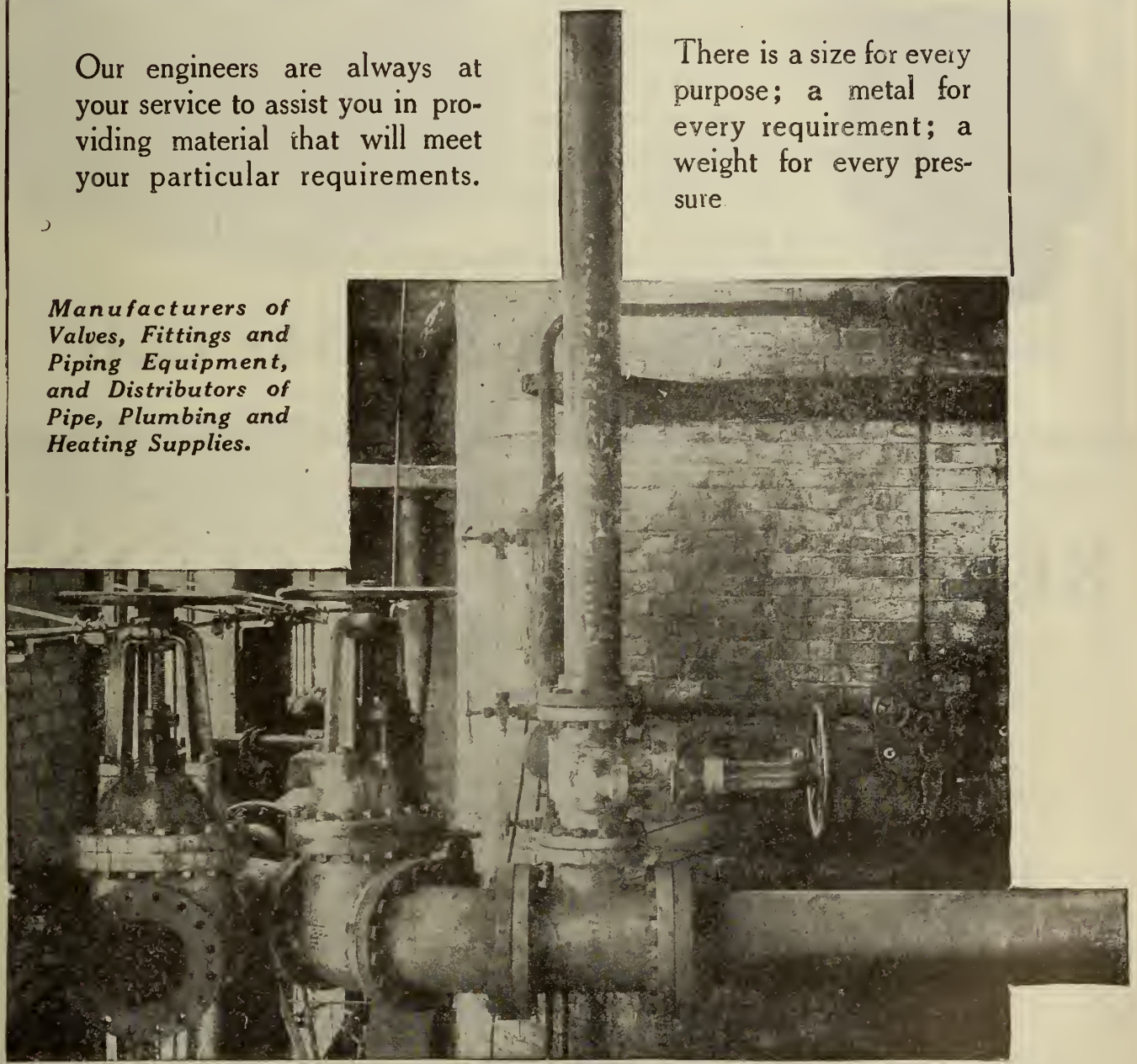
There is a size for every purpose; a metal for every requirement; a weight for every pressure

Manufacturers of Valves, Fittings and Piping Equipment, and Distributors of Pipe, Plumbing and Heating Supplies.



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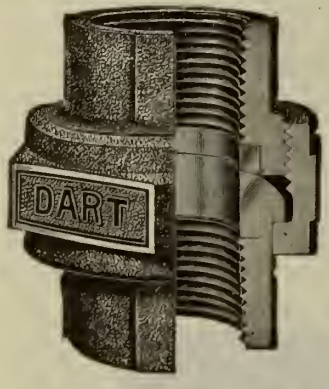
Dart Union Pipe Couplings Can NEVER-LEAK Because

BRONZE TO BRONZE AT THE JOINT CANNOT RUST OR CORRODE



The secret of the permanent efficiency of the Dart Union is due to the fact that the Bronze to Bronze, non-corrosive joints are held together by two extra heavy malleable pipe ends, surmounted by a heavy tightening nut. There is no deterioration of any kind at the joint.

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DART UNION PIPE COUPLINGS STAY TIGHT

Manufactured by Dart Union Co., Ltd., Toronto

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TO SAVE FUEL

⅛-inch Deposit on Tubes Increases Coal Consumption 30%
¼-inch Deposit on Tubes Increases Coal Consumption 66%
½-inch Deposit on Tubes Increases Coal Consumption 150%

MILLER'S BOILER CLEANING EXTRACT

Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

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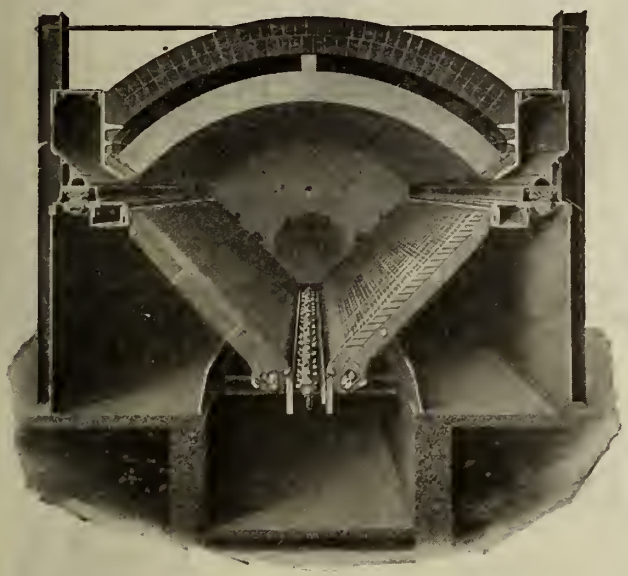
38-40 Youville Square, MONTREAL

Reducing the Cost of Steam Making



Back in 1907 the New York Air Brake Co. became interested in the possibilities of savings to be made by using

MURPHY AUTOMATIC FURNACES

in place of hand-firing methods. A test made on a 150 h.p. boiler, hand-fired, showed a cost of 20.39 cents per 100 lbs. water evaporated. A Murphy was then put in under this same boiler, reducing the cost to 14.49 cents per 100 lbs. of water evaporated.

This *demonstrated saving,* together with smokeless operation and low maintenance, has led to *three repeat orders* received from this company.

At that time coal cost $2.95 a ton at their plant—to-day that won't cover the freight per ton to most plants.

Think how much more tne Murphy can save at today's coal prices!

Find out what a Murphy can do for you in your plant. Send for Catalog HM-7.

For information on RILEY UNDERFEED STOKERS for large boilers, see advertisement in last issue or send for RILEY STOKER Catalogue HR-7.

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DETROIT MICH. U. S. A.

Accurate Control
OF
FIRE PUMPS

Your fire pumps should at all times be ready to deliver INSTANTLY their capacity volume of water.

In case of fire, failure to so deliver may be the cause of your plant's complete destruction.

Fisher Pump Governor
(TYPE 1)

will accurately and consistently control the action of your fire pumps.

Tested, approved and listed as standard by the National Underwriters' Laboratories.

For over forty years it has led the field in continuous, dependable service. Many of the "old timers" are still in use.

Made of the highest grade materials—the Fisher lasts a life-time.

Its simple, sturdy construction enables it to function perfectly with minimum attention and repair.

Valve and seats are made of our special formula, hard phosphor bronze, which resists corrosion and wire-drawing.

Our book, "POWER PLANT SPECIALTIES" will tell you all about the Fisher Line. Write for it today.

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Following is a partial list of Fisher Regulating Devices:

**Steam Pump Governors*
**Vacuum Pump Governors.*
**Brine Pump Governors*
**Oil Pump Governors*
*Piston or Diaphragm types with either spring or lever and weight control.
Reducing Valves
Tank Controllers
Back Pressure Valves
Exhaust Relief Valves
Steam Traps
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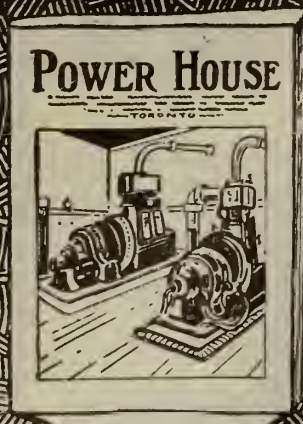

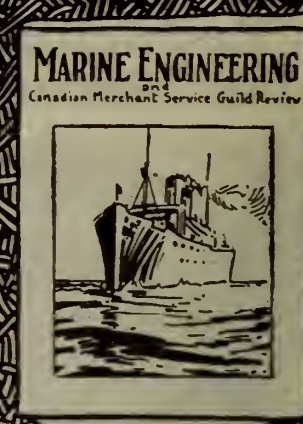

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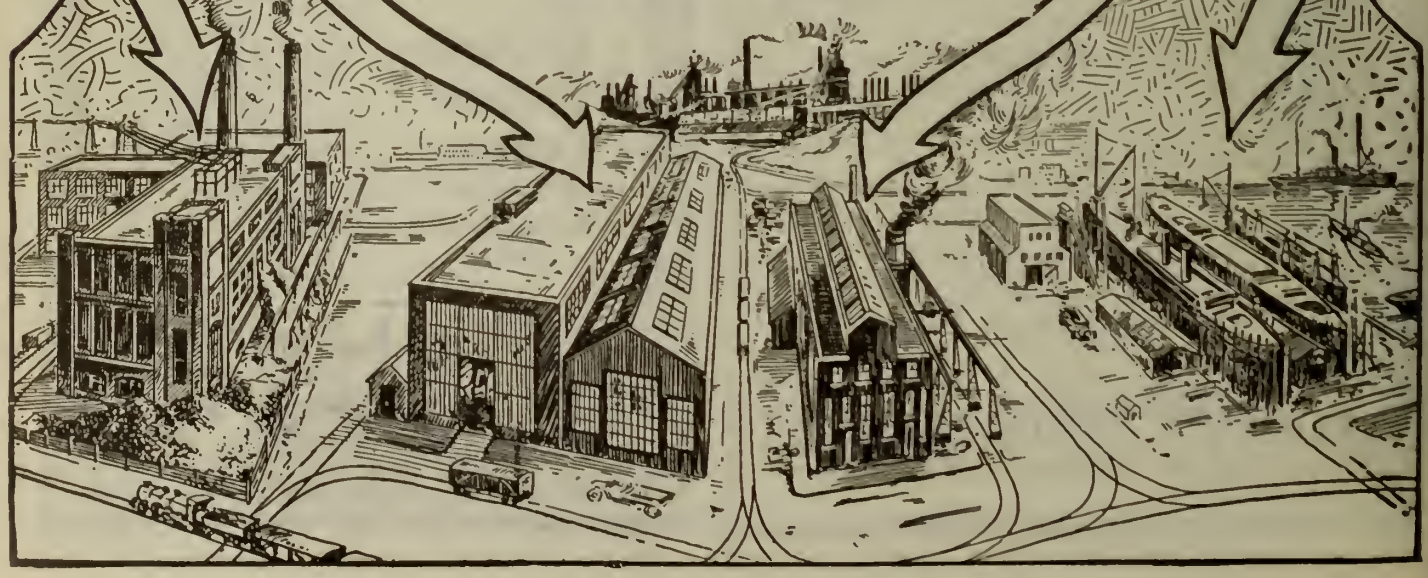

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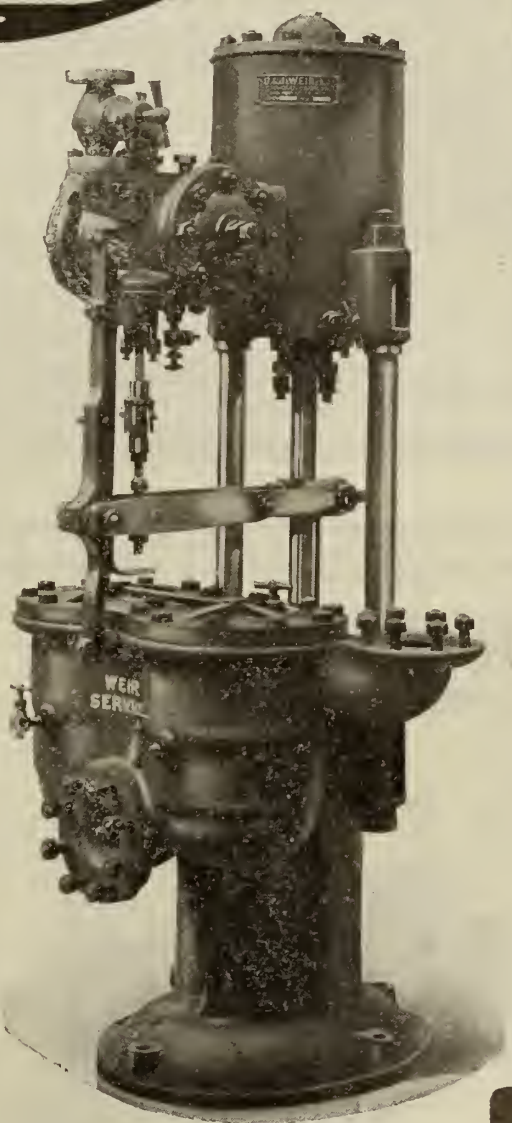

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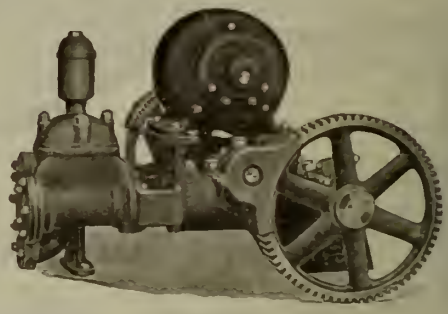

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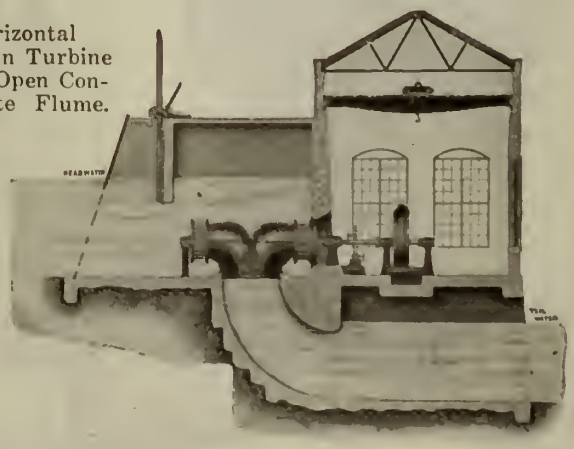

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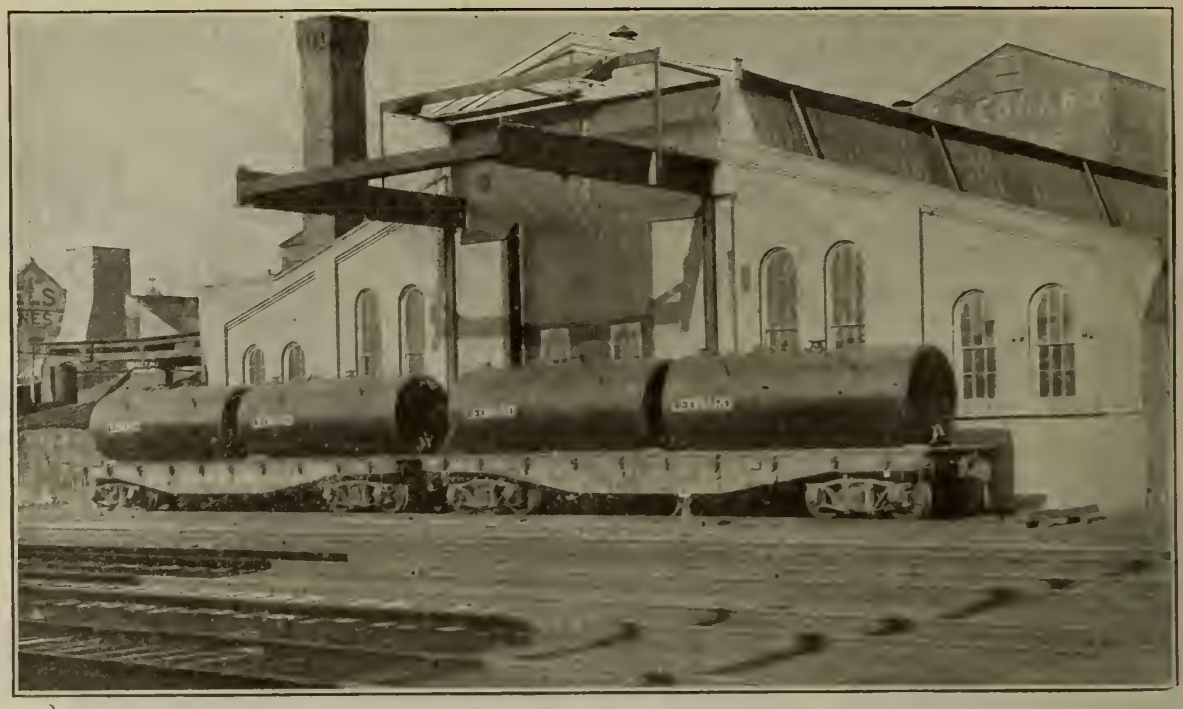

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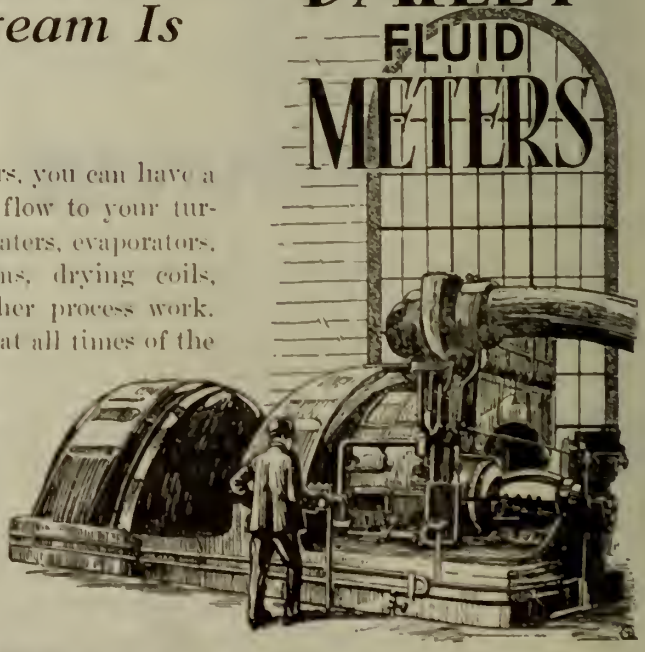

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"Vigilant" Safety Water Column

A *safety appliance* necessary for protection against the dangers incident to high and low water levels in steam boilers.

THE "VIGILANT" SAFETY WATER COLUMN will automatically sound an alarm and notify the attendant whenever the water level approaches either danger limit. It thereby safeguards life and protects the boiler from serious disaster which may be caused by the low level allowing the fire to play on the crown sheets and tubes when unprotected, or extreme high level which causes priming of the boiler and consequent damage to the power unit and the connecting pipes and valves.

The action of the "VIGILANT" operating mechanism is simple but positive. The single float actuates the double acting valve through the medium of stops set for high and low level limits. When the water approaches either danger limit the valve is opened, permitting steam to pass and blow the signal whistle.

A sediment chamber is provided at the bottom to trap scale or dirt which may enter the Column; Gauge Cock connections are tapped on both sides to permit right or left hand assembly; the top is removable for inspection of working parts, and all parts are renewable.

The "VIGILANT" Safety Water Column is recommended for working steam pressures up to 250 pounds; is made in a variety of sizes to suit all makes of boilers, and from the extensive line of LUNKENHEIMER Water Gauges and Gauge Cocks available a combination can be selected to suit every individual installation.

Specify LUNKENHEIMER "VIGILANT" Safety Water Columns and insist on getting what you specify.

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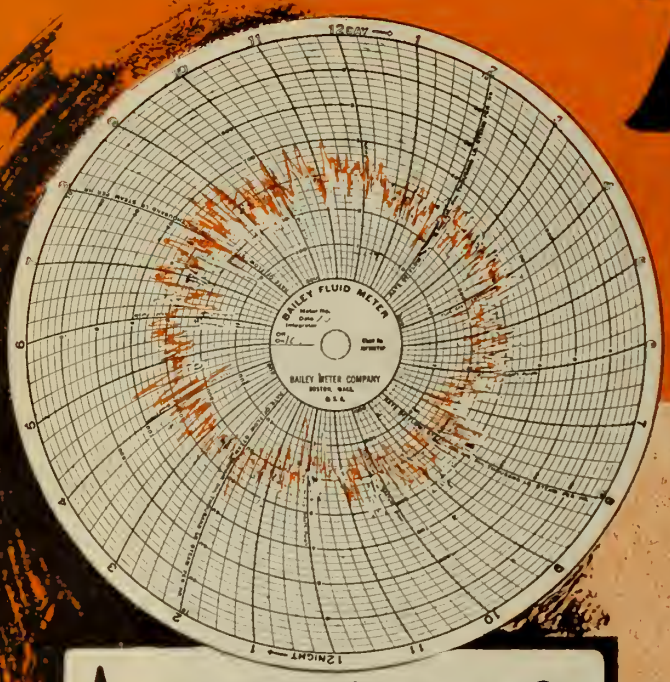
The Chart Continuous



Average Load for 12 Hours 267% of Rating

THE charts above—made during two successive days—are merely representative of two weeks of continuous day and night overloads, met without a single hitch by Jones "A-C" Stokers installed under 320 H.P., B. & W. Boilers in a big paper mill*. A plant capable of making these charts is ready for any load demand.

Eight boilers are equipped with Jones "A-C" Stokers, which replaced natural draft mechanical stokers so that greater ratings and efficiency could be secured.

Note the chart above, showing an average of 27,000 lbs. of steam per hour—equivalent to 267% of rating. The period between 8 and 12 o'clock on the chart at the right shows an average reading of 30,000 lbs. of steam per hour.—equivalent to 297% rating.

"The grade of coal used made no difference in rating," said the Combustion Engineer, "for we produced with Coal of 14,000 B. T. U. down to 11,400 B. T. U."—the grade of coal burned in many Canadian plants.

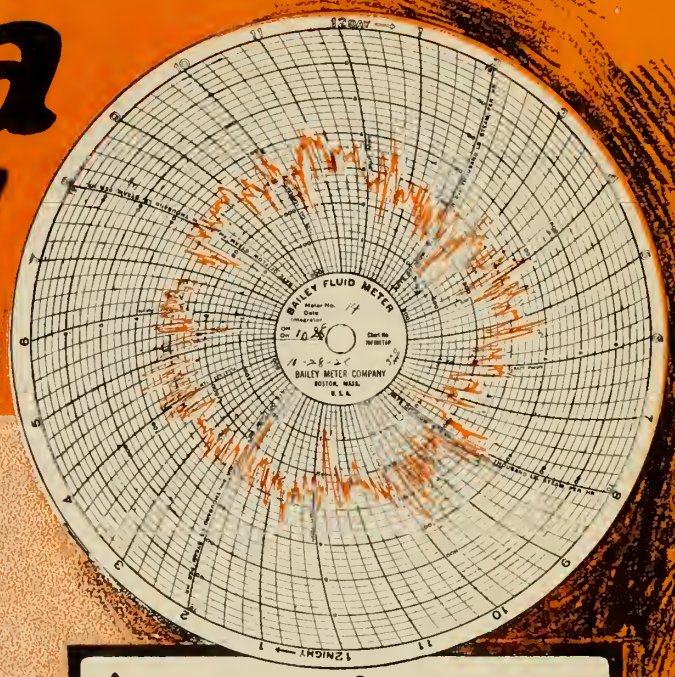
This excellent performance, coming after two weeks of hard driving, emphasizes an advantage that is shared by all Jones installations

**Name furnished on request.*

Pays for Itself— Then Pays Dividends

Jones

Story of a Overload



Average Load for 4 Hours 297% of Rating

--The Jones "A C" is not only capable of meeting heaviest overloads, but-- what is more important--it will stand the gaff of continuous overloads.

This is because the Jones "A-C" is simpler and more rugged in construction than any other multiple retort stoker of the same general class.

There are no crankshafts, gears, gear shifts, chain drives, or shearing pins to cause trouble; no complicated dumping mechanism; instead, the simple, hand operated balanced dump plate that has proved its superiority.

The one and only moving part within the furnace is buried deep in the green coal. Shut-downs for repairs are practically eliminated.

Why results like those recorded by the charts can be duplicated in any Canadian plant day in and day out, is fully explained in the new "A-C" catalog. You have your copy?

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The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized as The Under-Feed Stoker Co. of Canada, Ltd., and the reorganization makes available for Canadian power users the extensive engineering resources of The Under-Feed Stoker Co. of America.

JONES STOKER

"A C"

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Rotary Jet Condensers and Vacuum PUMPS

Sole Canadian Manufacturers

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The Rotary Jet Condenser is used in connection with steam turbines and reciprocating engines. It is particularly adaptable to sugar and salt boiling plants, etc. The Rotary High Vacuum Air Pump is identical in principle with the Jet Condenser and possesses similar advantages. **Made in Canada by the G. & McC. Co. only.**

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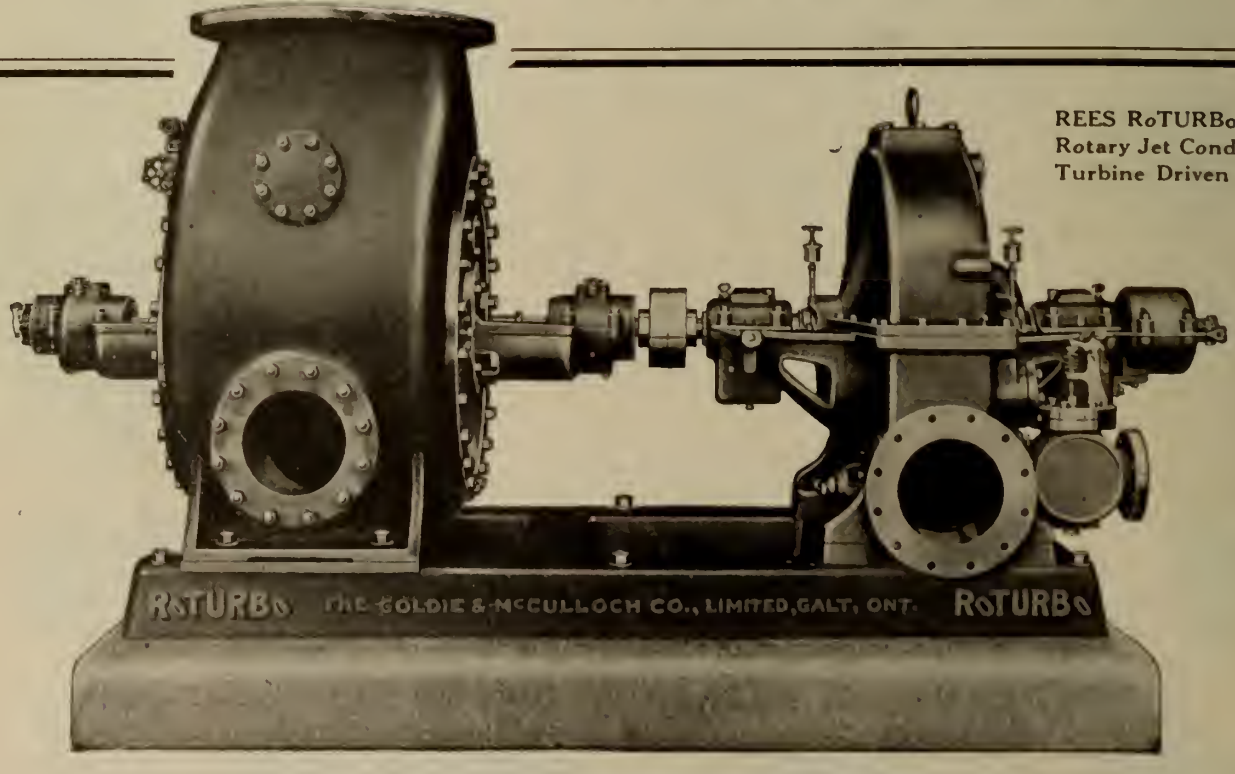

REES RoTURBo
Rotary Jet Condenser
Turbine Driven

POWER HOUSE

Members of the 'Au 'it Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

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The Hamilton Plant of the Canadian Cottons Ltd.

The Steam Plant, Which Has Been Installed to Supply Steam For Process Work and Heating, is of the Most Modern Design, and Embodies Interesting Features.

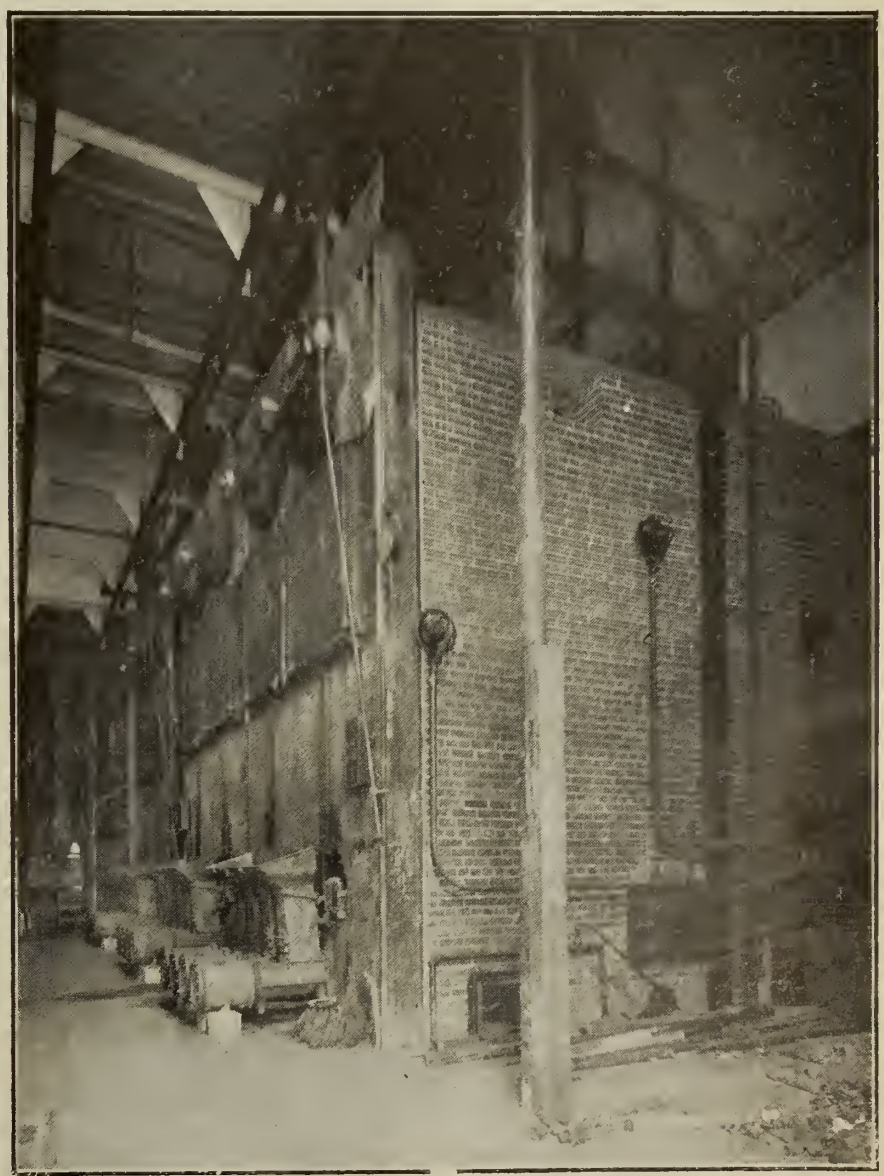
BY T. H. FENNER

THE Canadian People are continually demanding more cotton and textile goods. In order to supply their demand a very large milling industry has grown up in the Dominion. New mills are being built, and the existing mills are adding to their premises and doubling up the number of spindles. One of the latest additions to an existing mill is the new building of the Canadian Cottons on MacNab Street in Hamilton, and the increase in the manufacturing capacity has necessitated the installation of a very modern steam generating equipment. Through the courtesy of the management, we were enabled to make an inspection of this plant, and secure some good photographs for the benefit of POWER HOUSE readers. The plant is almost entirely devoted to the generation of steam for process purposes, practically all of the power being obtained from outside sources, the only exception being in the dyeing room, which is driven by an engine. This on acccount of the necessity of absolutely uninterrupted operation, which is a sine qua non of successful dyeing, and an interruption to the service on the outside of the mill would entail considerable damage and loss.

The General Arrangement

The general arrangement of the plant can be seen from the various photographs reproduced here. The building itself is square, and stands in a court yard formed by the buildings of the old factory, and from the outside does not look particularly like a power plant, the principal point which makes one recognize it being the ash shute projecting from one end. Any doubts about the purpose of the building are quickly dispelled when the doorway is entered. Standing at the doorway in the west corner of the power house, from which one of our photographs were taken, the boilers are in front to the right. The firing platform in front of the boilers is of ample width, and the travelling hopper which weighs and delivers the coal from the overhead bunker is seen in the passage. The boiler room is divided lengthways by a concrete partition, behind which are situated the feed water heater, the fan for the forced draught to the boilers with its two engines, the feed pumps, the hot water circulating pumps, and the water softening outfit. There are two galleries above this pump room, the first one containing the heater for the factory water, and the hot water storage tank, while the gallery above is given up to the soft water storage tank, and a regenerating tank for the water softening plant. This top gallery is on a level with the boiler tops, and communicates with them by means of an iron grating.

At the east end of the boiler room are situated the coal handling and ash



VIEW OF FIRING PLATFORM, SHOWING STOKERS AND SOOT BLOWERS.

handling apparatus, and there is a broad basement under the boiler room floor for handling the ashes into the conveyor. Good solid iron ladders and gratings are provided for getting up to the galleries, and the whole plant gives one an impression of compactness and convenience without any crowding.

The Boiler Installation

The amount of steam that is required for the operation of a mill of this kind can be judged by the boiler installation. There are at present three Goldie and McCulloch boilers of the B & W waters tube type, each one rated at normal capacity for 430 horse power. Besides this, provision has been made for the addition of a fourth boiler. The present capacity is thus practically 1300 horse-power at normal rating, and the boilers can be forced to 225 per cent of rating, or 125 per cent over the normal. This would give a capacity of practically 3,000 h. p. on the present installation when run to their highest overload, and with the fourth boiler 4,000 horse power per hour could be achieved. In terms of water evaporated per hour this means that with steam at 130 lbs. per square inch and feed at 180 degrees there would be at normal rating 41,262 pounds of water evaporated per hour while at the 225 per cent rating the evaporation would be 92,839.5 pounds.

The boilers are noticeable for being set very high above the grates in the approved modern fashion, and one cannot help but contrast the arrangement as it stands with the old fashioned idea of setting the boiler right on top of the grates. It is one of the contrasts that calls one's attention to the progress in engineering which one is too apt to take as a matter of course.

The boilers are fitted with the Jones A. C. underfeed stoker, and each boiler has four retorts under it. These stokers are guaranteed to deliver 225 per cent rating on the boilers for a period not exceeding four hours, and a steady load of 150 per cent rating. They work under forced draft, and automatic regulation. The efficiencies guaranteed are 76 per cent at normal rating, 75 per cent at 150 per cent rating and 73 per cent at 225 per cent rating.

The rate of working the stoker is controlled by the automatic regulators which can be seen in front of the partition. These regulators are the Cole Automatic valve, and are in turn controlled from the fan engine. The fan engine is controlled by a sensitive control valve in the steam line, which automatically increases the speed of the engine if the steam pressure drops. This again increases the revolutions of the automatic valve controlling the number of strokes per minute made by the stoker, and steam is brought up rapidly. The fan engine slows down with the increase in steam pressure, and the stoker in turn slows down. The regulation is very close. Each stoker retort has its own valve, and these can be adjusted without interfering with any of the others. Thus in a four retort stoker, such as is fitted in this installation, it might be necessary to adjust the valves on the two outside stokers to give more strokes per minute than the two inside ones. This adjustment would be independent, the general control still being obtained from the fan engine. The Cole automatic valves are driven by a belt the driving pulley being keyed to the fan engine shaft.

VIEW OF BOILER TOPS AND FRONT, FROM GALLERY.

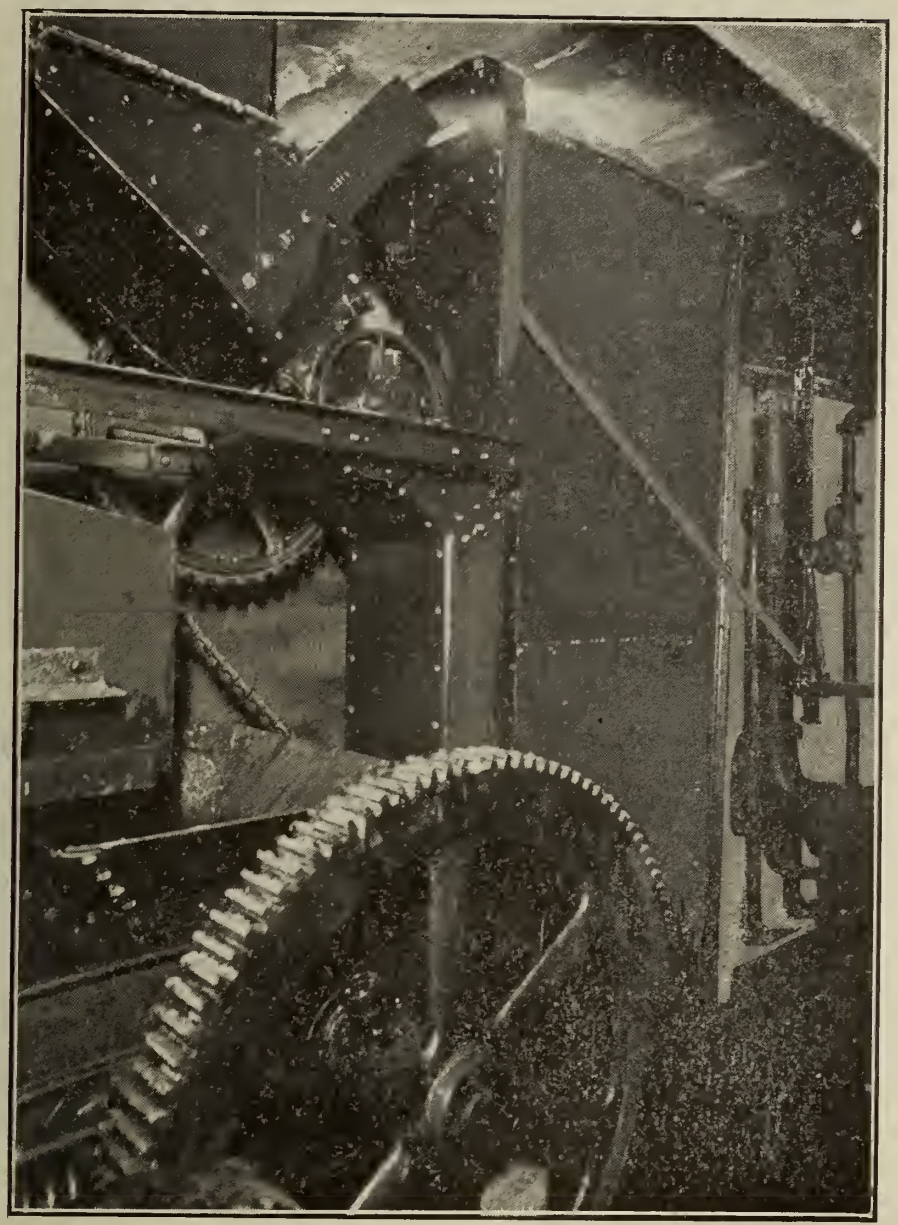
On the front of each boiler setting there is a three-in-one draft gauge made by the Precision Instrument Company. These gauges are easily read from any position on the firing platform, and tell the operator at a glance the static pressure at the fan discharge, over the fire, and in the last pass of the boiler. These readings convey at once an indication of the state of the fire, and also of the baffling, and condition of the tubes as far as the soot deposits are concerned. If the baffling is not in good conditon there will naturally be very little drop between the furnace and the back pass, while on the other hand, dirty tubes by causing higher resistance would indicate a greater drop than normal between these two points. In order that the tube may be kept as clean as possible, each boiler is fitted with a set of Diamond soot blowers.

Coal Handling Plant

It will be seen that thus far the firing of the boilers is taken care of with practically no human handling. This principle has been carried out throughout the plant as far as practicable, and a complete coal and ash handling system is included in the installation, supplied by the Canadian Link Belt Co.

The coal coming into the plant is delivered on the outside of the power house to a hopper, which delivers it onto a shaking platform. The opening of the hopper is covered with a grating having a 12 inch mesh. The shaking platform runs the coal into the opening of a 23 inch by 24 inch two roll coal crusher, and from this it drops into the boot of a vertical conveyor. It is elevated by this conveyor up to the roof of the building, and then delivered into the working bunker, until this bunker is filled, when the coal is spilled over into the reserve bunker. From the working bunker the coal descends by gravity into the hopper of the traveller which weighs it before delivering it to the stoker hopper. This travelling weighing hopper has a capacity of half a ton, and is moved along the boiler fronts by hand. The coal is weighed automatically and a ticket is punched on the scale within easy reach of the operator on the boiler room floor. In order to reclaim the coal from the storage bunker when required, a chute is led from the bottom to the boot of the vertical conveyor, and in this way it is delivered again up to the daily needs bunker. There is also a by-pass provided around the coal crusher, so that coal can be delivered direct to the elevator without going through the coal crusher if such practice should be necessary. The coal crushing and conveying machinery is electrically driven, and the control is situated in the boiler room, in a small room at the side of the boilers. An ingenious electrical locking arrangement is provided on the control, by which it is impossible to start the crusher without at the same time starting the elevating conveyor. On the other hand the conveyor can be started without the crusher. This eliminates all danger of getting the machinery jammed up through the coal being delivered to the crusher with no means of taking it away, and this safe guard was introduced on the initiative of Mr. Piers the supervising engineer of erection.

When the coal has fulfilled its purpose in the furnace, and given up everything but the incombustible material it contains, the ashes are dumped by the stokers into the sloping ashpit, which leads to the tunnel under the boilers. These ashpits are furnished with large doors, opening outwards, and the ashes are pulled or descend by gravity onto



THE COAL CRUSHER.

the floor of the tunnel. Directly opposite each set of ashpit doors, there is an opening in the floor communicating with the 8 in. American Steam Conveyor ash conveyor. and they are drawn into this, and blown up to the ash bunker, which extends nearly the whole height of the building. This bunker which is of large capacity, is furnished with a chute at the lower end, and this chute projects into the space over the coal receiving hopper. Carts can be backed under here, deliver coal, and if necessary take away the ashes on the return load. All the driver has to do, is to open the gate on the end of the chute and his cart is filled with ashes automatically.

The photograph shows a view of the ashpit tunnel, the round pipes overhead being the air ducts from the fan to the furnaces. The up-going pipe of the ash conveyor can be made out in the far right hand corner.

The Steam Pipe Arrangement.

When one looks at the photograph of the boiler tops the impression of ordered neatness is very striking. The writer was much impressed by the appearance when he reached the top of the ladder leading to the third gallery on which is contained the storage tank for soft water. This gallery is on a level with the boiler tops, and one gets a very good view from there. The photograph which perforce had to be taken from one end does not quite do justice to the general effect which can be obtained when one stands in the middle The writer has had so many painful experiences of boiler tops that were dirty, dark, dusty and uncomfortable that he is able to appreciate a pleasing layout when he stumbles across one

The tops of the boilers are insulated with a covering of Armstrong cork brick, which makes a very nice finish, and looks as though it will stand being walked on without disintegrating The safety valves, of which there are two on each drum, or four to each complete boiler, have a waste pipe on each drum leading through the roof, while a drip is placed in the elbow of each waste pipe to keep the pipe drained The main steam pipe is taken from the centre of the header joining the two drums, and is furnished with a Crane non-return valve The large bends used for expansion purposes can be well seen in the illustration, and form practically a semicircle The three pipes from the boilers are connected on to a main header which can be also plainly seen, and from this header are taken the pipes to the mill, and to the auxiliaries in the boiler room. At the centre of the header, or between boilers 2 and 3 can be seen two large valves which serve the purpose of isolating one half of the header from the other, so that steam can be supplied from either side quite independently. The main steam to the mill is taken off the header right between these two valves, while the steam supply to the feed pumps, water softener, fan, engine, etc., is taken from branches which are in duplicate on each side of the dividing valves. The same idea is used on the feed header which runs along the front of the boilers, the discharges from the two feed pumps being connected in at either end.

The Pump and Fan Room.

Leaving the top of the boilers reluctantly, and passing the middle gallery with its machinery for the time being, we reach the ground floor and pass behind the dividing partition into the fan and pump room. The water softening plant is at the far west end of the room, the fan occupying with its engines the centre, while the feed pumps and heater, together with the circulating water pumps are at the east end.

There are two centrifugal pumps, one driven by a Terry steam turbine and the other electrically driven, to supply hot water forced circulation for heating the new buildings A storage tank on the gallery above, is connected with a Griscom Russel heater, and this heater supplies the heat to keep the water in the circulating system to the required temperature. All the returns from the steam pipes in the mill are delivered to a Cochrane heater, the exhaust from the fan engines, pumps, etc., also going to this heater. The rated capacity of this heater is 1,300 horse power, and it has a heating capacity of 53,000 lbs. and a metering capacity of 60,000 lbs. water per hour. It is equipped with two V notch meters each of which have a capacity of 30,000 lbs. per hour, and the water going to the feed pumps passes over these notches. The exhaust inlet is twelve inches and the outlet is ten inches in diameter.

The water is delivered from the heater to the boilers by two Weir feed pumps, manufactured in Canada by Peacock Bros., Montreal, the size of these pumps being 7 x 9½ x 15. Either pump is capable of supplying the boilers but the pumps are in duplicate in line with the general policy adopted in the construction. Each pump is controlled by a Chaplin-Fulton vigilant regulator.

The Sturtevant fan which supplies the air for the Jones stokers has a capacity of 34,000 cubic feet per minute at a static pressure of four inches water. There is an engine at each side of the fan, and these are attached to the fan

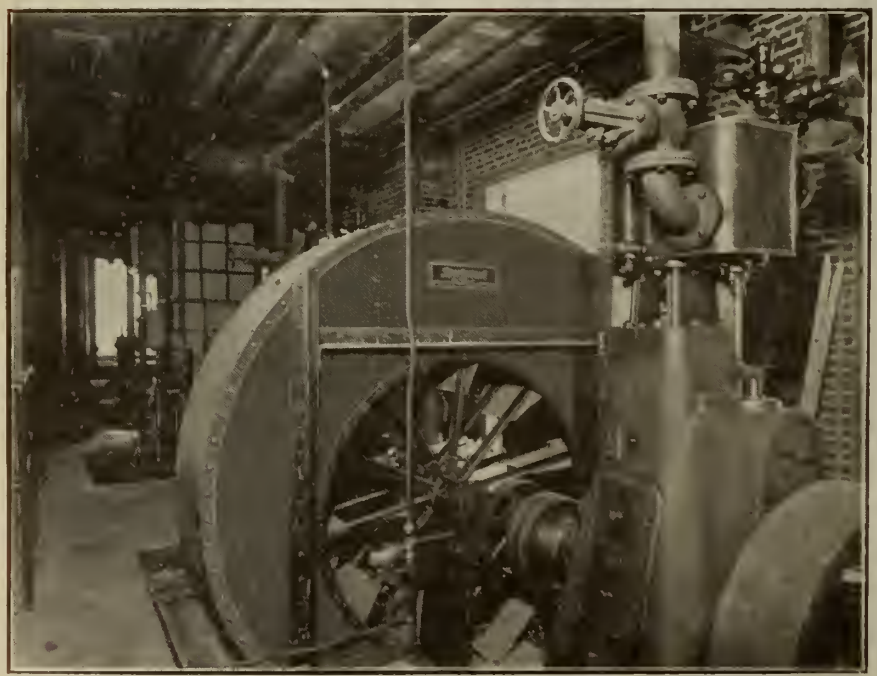
shaft by means of flexible couplings. Our illustration shows one of these engines and the fan, while the feed pump can be seen in front of the heater. The pumps are of course sunk in a pit below the heater in order to get away from any trouble due to vaporisation of the water in the suction. The Ruggles Krausmann Regulator is behind the fan and cannot be seen in the illustration. There are pulleys on each fan shaft for driving the Coles regulators previously referred to. The air is delivered from the fan through the ducts shown in the illustration of the tunnel. The fan is not in duplicate, but there is little necessity for such a course, the providing of duplicate engines being all that is necessary. The likelihood of any mechanical breakdown occurring to the fan is remote. The size of fan and engine can be well appreciated from the illustration.

THE ASH TUNNEL SHOWING FORCED DRAFT DUCTS.

The Water Softening Outfit.

The factory as before stated pumps its water from the Hamilton Bay, and this water as our readers are no doubt aware, is of a very turbid nature, so that it is absolutely necessary that it should be filtered for process work. In addition to this it is necessary to get as soft a water as possible, and the plant installed gives a water of zero hardness. The equipment is manufactured by the Permutit Co. of New York and is the same as that installed in the Canadian Cottons plant at Cornwall, Ont. Its capacity is 4,000 gallons per hour, or 40,000 gallons for a ten hour day, and the water delivered is absolutely free from all scale making minerals. It is claimed that with this system of water softening the boiler cleaning is entirely done away with, as there is absolutely nothing in the water to be precipitated when it reaches the boiler.

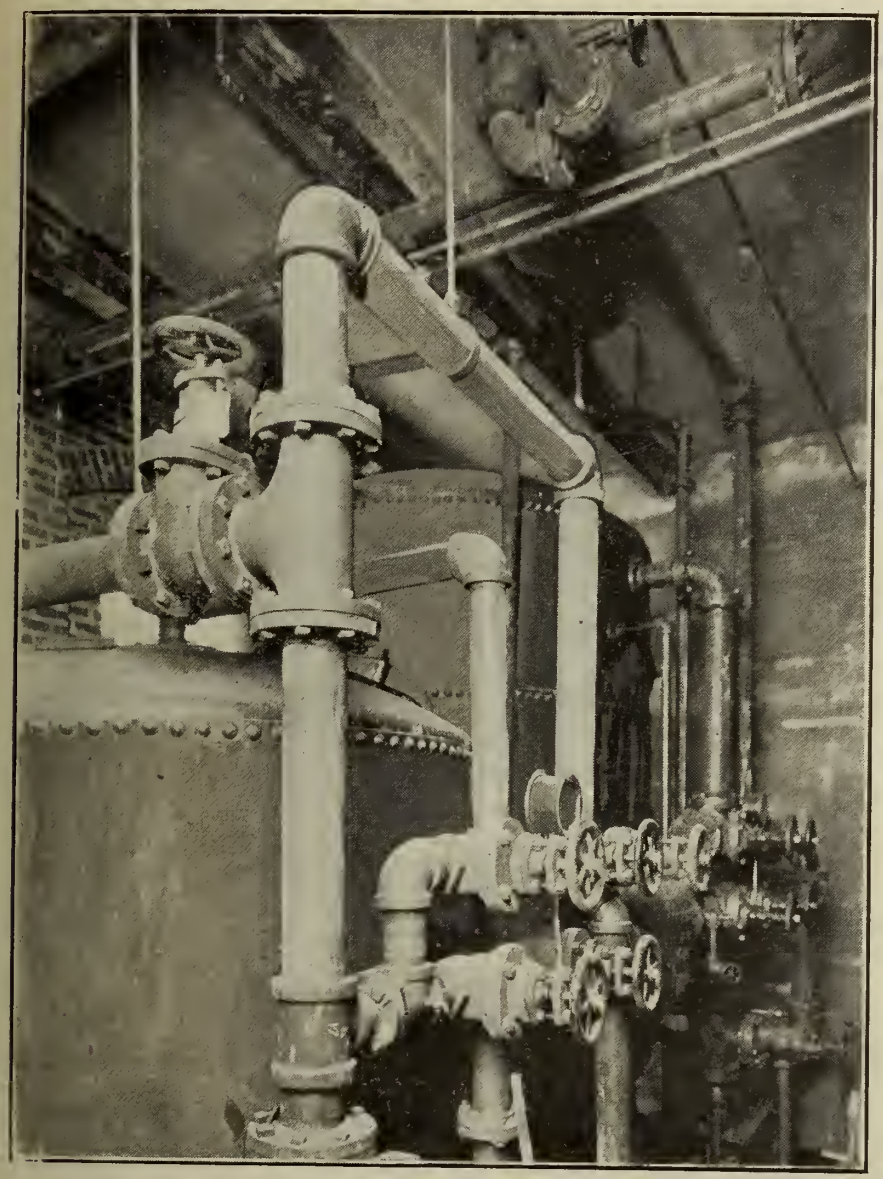
The water coming from the bay passes through the 72 inch diameter vertical clarifyng filter and from there goes through the 90 inch diameter vertical clarifying filter and from there goes through both these vessels. These vessels can be seen plainly in the illustration. After passing through the softener the water goes to the storage tank on the gallery which is shown in another illustration. The capacity of this tank is sufficient to meet the peak load requirements, and also to keep the plant going while the regenerating process is going on.



THE FORCED DRAFT FAN

The process is based upon the properties of a chemical substance known as "Zeolite," which are a form of crystals, and possess the property of being able to exchange their chemical base for that of bodies to which they are brought in close contact. This property is known to be possessed by fertile soils, and it is believed that the presence in the soils of these crystals is the cause of this power. The main constituent is silica.

The use of this property commercially was first made possible by Dr. Robert Gans, and his process was acquired by the Permutit Company. Dr. Gans produced a synthetic crystal which is absolutely insoluble in water, and possesses the property of giving up sodium to

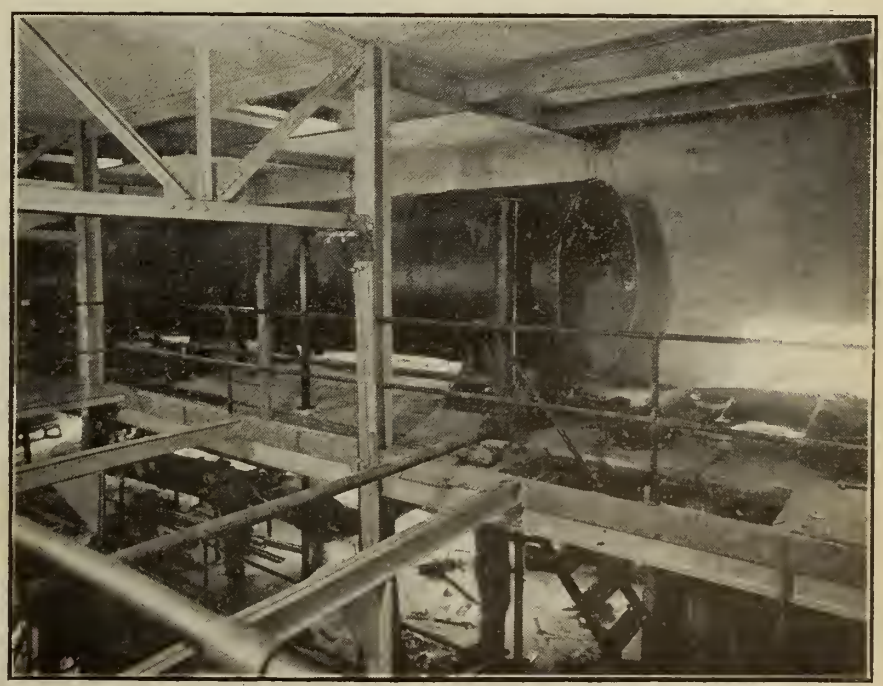


THE WATER SOFTENER

the water in exact proportion to the quantity of mineral contained in it, and absorbing this mineral. The process is thus one of exchange, the sodium in the "Permutit" being given up for the calcium and magnesium in the water. Another property of the "Permutit" is that after being in use for some time it can be restored to its original efficiency by simply soaking it in brine. In this operation the reverse process takes place, the calcium and magnesium being thrown off and the sodium from the brine is taken up. This leaves the "Permutit" ready to take up the excess over again. This reverse exchange is called "Regeneration."

The "Permutit" Zeolite is insoluble. For this reason a great excess of the re-agent can be placed in the filter to drive the reaction to completion, producing a water of zero hardness without the possibility of the treated water showing the presence of the excess. Only an exchange of hardness for sodium is possible and only as much sodium is given up by the "Permutit" as is required by this exchange. If the water is harder it gives up more sodium; if it is softer it gives up less; in this way the softened water is automatically kept free from the excess of chemicals and causticity. When the "Permutit" filter has produced its designed quantity of zero water, as may be seen by a water meter attached, the regeneration follows. The "Permutit" is back-washed for a few minutes, the brine is admitted with a syphon arrangement into the bottom of the softener, passing slowly up through the "Permutit" bed for eight to nine hours. The salt is re-claimed to the salt tank after regeneration. By the time this salt water is forced out of the "Permutit" filter, by the pressure of the incoming raw water, back into the salt tank, the filter is ready for its next operating run. The cost of treatment, therefore, is that of salt for regeneration. Common salt is used, which costs in bulk about three-quarters of a cent per pound, and in this case 7¾ pounds of salt is required for every one thousand imperial gallons of water softened. The "Permutit" Zeolite depreciates in quantity from 2 to 5% per year. In other words, a tank holding 200 pounds with a depreciation of 5% would have to have but four pounds of new material added yearly.

Have Bought Equipment.—Edmonton city council has decided to purchase a 5,000 k.w. Canadian General Electric Company's turbine, with Wheeler condensor, for use at the power plant. The price of the turbine and condensor will be $171,000, but the total amount involved, including installation, new drafts, ash handling plant, and other improvements and accessories, will come out at about $250,000. An order for the unit has been given and delivery guaranteed not later than three months. According to the statements of the firm's representative, the unit should be ready by October.



SHOWING SOFT WATER STORAGE TANK.

A Course of Instruction for the Graded Certificate

This Article, Which Will be the Last of the Series, Gives a Few More Examples of Indicator Cards, Dealing Especially With Those of Compound Engines.

BY T. H. FENNER

IN taking cards from a double acting engine it is always the practice to take them each end, one immediately following the other, and if used to the job, a man can usually indicate both ends within the space of three revolutions. This gives an opportunity to get a card from each end while conditions are pretty much the same in an engine with a variable load. Of course where a load is absolutely steady as in the case of a ship's engines in fine weather, there is no need for much haste. In the case of a high speed automatic engine direct connected to a generator, there may be considerable fluctuation of the load within the space of a few revolutions.

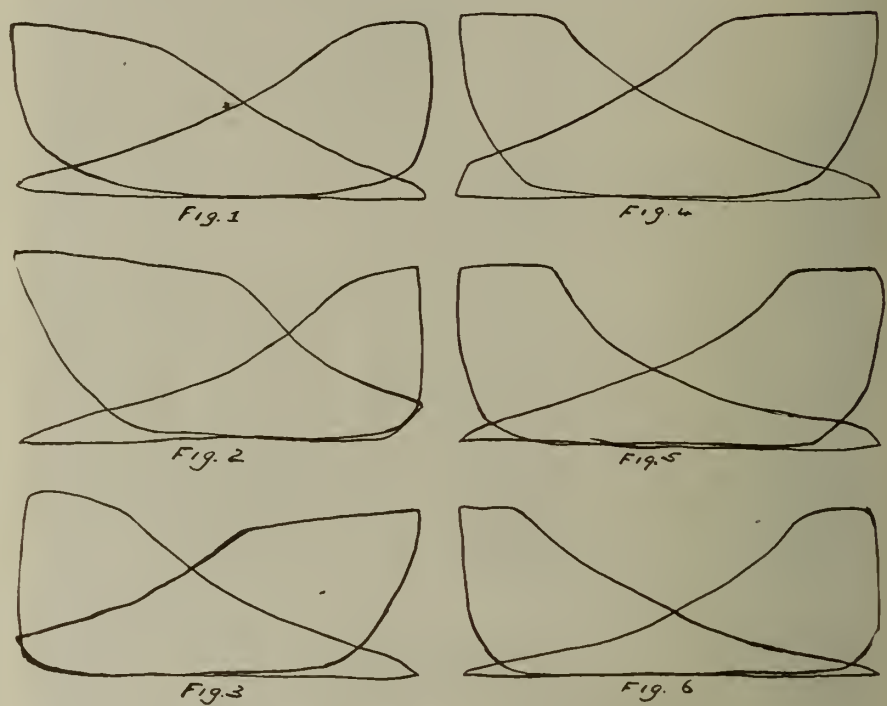
The two diagrams being on the same card give excellent opportunity to study the comparative dimensions of each and also to get the power developed at each end of the cylinder, the mean of which is the power of the engine. The object is to have the valves so set that the mean effective pressure at each end of the cylinder, or rather on each stroke, shall be the same, the power developed being slightly different on account of the diameter of the piston rod decreasing the effective diameter of the piston on the crank end of the cylinder. Sometimes allowance is made for this in working out the power, but more often it is neglected, the error on the total power not being more than about 2½ %. In large power engine this is negligible unless very accurate results are required.

The first example shows the effect on the card of the angularity of the connecting rod, when this is not counteracted by the setting or design of the valve. The cut off on the crank end is earlier than on the head end, and this induces a lower mean effective presure than that on the head end, which, coupled with the area of the rod, and the extra compression, makes a very much unbalanced engine.

Figure 2 shows the card that would be taken if the slide valve were too near the crank, due to wear or faulty setting, and Figure 3 the effect when the valve is too near the head.

The remedy for figure 1 is to increase the lead on the front end, until the cut off is equalised, or if anything a bit later than the head end, while in the case of Fig. 2 or 3 the valve must be adjusted by moving it on the spindle, or altering the length of spindle where that is provided for.

Figure 4 is an example of a Corliss engine with single eccentric, where the knock off cams on the steam spindle have not been properly adjusted, thus making the cut off unequal at either end. It must be remembered that in engines with a drop cut off gear, the adjustments have to be made on the governor arms, provided the eccentric is set correctly. Of course, for the opening to steam the correction must be made by means of the steam rods, the reach rod, or the eccentric itself.



SOME MORE EXAMPLES OF CARDS.—SEE TEXT.

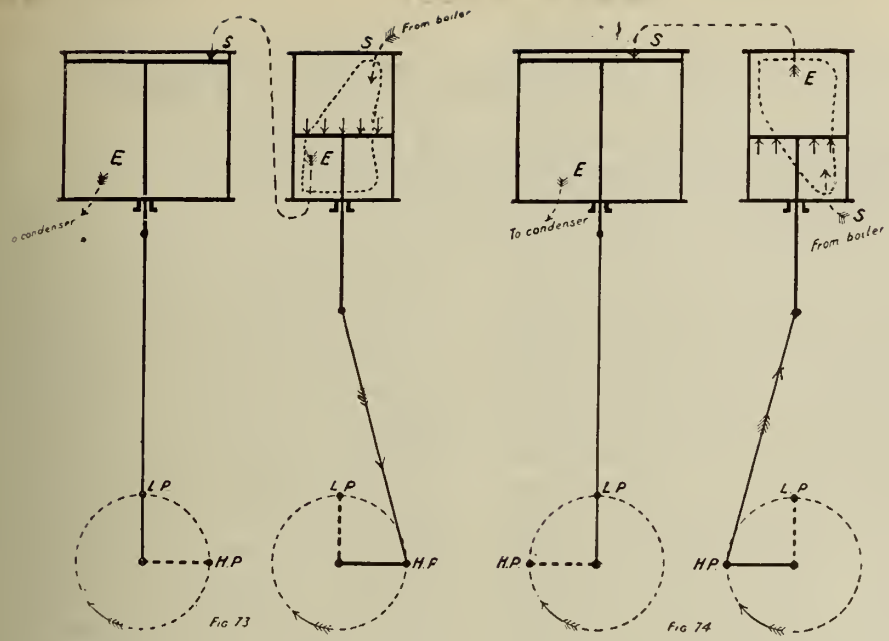
Fig. 5 shows cards from a Corliss engine with everything correct, cut offs equal, leads the same, and compression about the same.

Let us consider now a case where these conditions do not exist due to faulty setting. On the head end the lead is late, cut off is early, while exhaust opens at the right time, and compression also occurs at the right moment. On the crank end the lead is early, cut off is early while the exhaust opening and closing are correct. Let us see what defects this would point out. At first glance, lead early and cut off early would incline us to say that the eccentric was too far ahead, but the fact that the exhaust functions are correct at both ends, and this is a single eccentric engine, shows that the eccentric must be correct. It also shows that the length of the reach-rod must be correct, otherwise the exhaust valves could not be right at each end. This narrows the search down to the steam arms and the governor rods

Taking the valve openings first. On the head end the lead is late, or in other words, the valve is late in opening to steam. This means that the steam arm has got to travel a longer distance than it should in order to pick up the latch hook which turns the valve swindle. Then we must bring the steam arm closer to the latch hook, or in other words shorten the length of the arm. On the other end the lead is early and the cut off is early. If the lead is not excessively early it will be better to leave this as it is, and consider the cut off. Now we have at the head end an early cut off, and also at the crank end the same thing. This means that at both ends the latch hook is knocked off too soon by the knock off cams, and in order to remedy this we must lengthen the reach rod between the two cams, which moves the cam on the head end farther back, and the front end farther forward, thus making the cut off later at each end and adjust the main governor rod to suit the altered length of the reach rods. These adjustments having been made the cards should be about right.

Supposing instead that the exhaust on the head and crank end had been wrong while the steam end was right. This would mean simply that the reach rods from the wrist plates to the exhaust valve arms would have to be adjusted. If the exhaust opens too late and closes too early the remedy is applied by decreasing the amount of lap which the valve has over the edge of the port, and this is done by shortening the rod.

In the case of a Corliss engine with two eccentrics, if the exhaust valves both show too early opening and closing, or too late opening and closing, then the eccentric must be adjusted. If the



SHOWING EFFECT OF SEQUENCE OF CRANKS (FROM "INDICATOR DIAGRAMS," McGIBBONS)

events are too early then the eccentric must be moved forward towards the crank while if too late, it must be moved away from the crank, unless the gear is indirect in which case the opposite will be the case.

Cards From Compound Engines

Cards taken from compound engines show exactly the same characteristics as those from simple engines, but it is usual to try and balance the load by the aid of the indicator. The division of the horse power equally between each cylinder gives an even turning moment on the cranks, and is very desirable. With compound engines the cranks are in most cases set at 90 degrees, and the H. P. crank leads the L. P. though there are cases where the L. P. leads. There used to be some compound engines with cranks at 180 degrees, but these were fitted with fly wheels and were used for marine works. The sequence of cranks is not of much importance in compound jobs but it is in triple expansion engines. Outside of a few large pumping engines, stationary engineers in Canada are not troubled much with triple engines, and it is hardly worth going into the question of these engines in this course.

The cards shown here illustrate the effect that the sequence of the cranks has in a compound engine. The first shows an engine with the cranks at 90 degrees, and the H.P. leading the LP.. and there is no receiver between the two cylinders. This also has an effect on the cards. When there is no receiver between the H.P. and L.P. then the back pressure on the H.P. rises more as the L.P. cuts off than when a receiver is fitted. There is not the same drop at admission into the L.P. with a receiver as without, owing to the greater volume of steam that the L.P. has to draw from. The difference shown here is that when the H.P. cranks leads the back pressure rises more in the H.P. on account of the angularity of the H.P. rod. There is little difference, however, and the effect is nothing like so much marked as in the case of triple engines. We are indebted for this illustration to "Indicator Diagrams" by W. C. McGibbon, M.I.E.S.

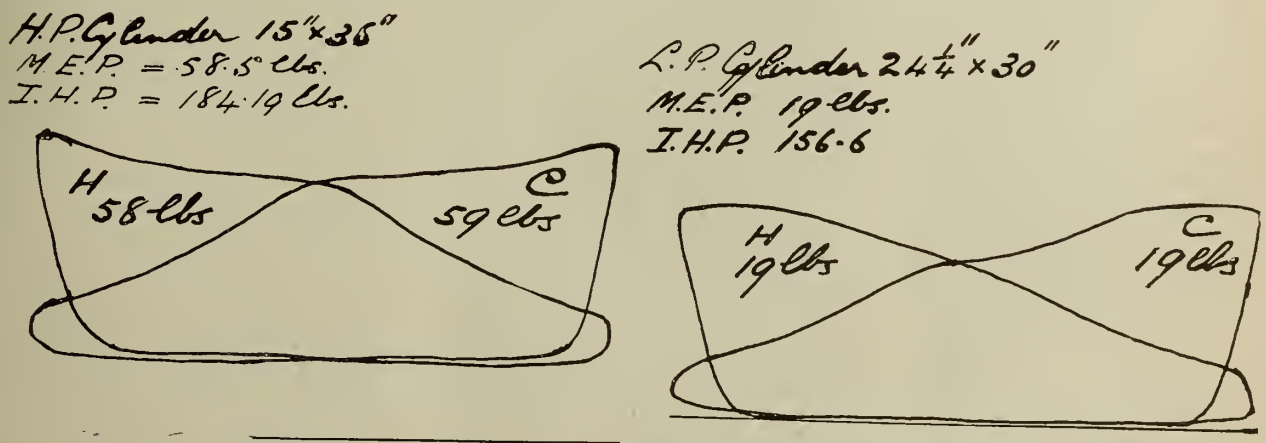
Conclusions.

We have dealt in this course with the subject of indicator diagrams sufficiently far to help out a man going up for examination, and we hope enough to interest him into going farther. The matter dealt with here is but an outline of the whole subject, but for obvious reasons we cannot attempt to deal any more fully with it in the space of this magazine. We have tried to make clear what we have gone into, and feel sure if the reader thoroughly absorbs what has been said, he will be in a good position to satisfy the examiners. For further information there are many excellent text books on this subject, and we would advise the reader who is interested to buy one and study it. The subject of indicator diagrams is a wide one, and full of interest, and the more the operating engineer knows of them the better man he will be.

We have dealt in this course with the main subjects which may be called for in examination, and feel that there is not much to be gained by going further However we should like to hear from those who have been following the articles, and receive suggestions as to what they would like taken up, and the opinion of the majority will decide. There may be portions which some readers would like reviewed, or some point which a reader may not be clear on, and would like to see more in detail. The matter rests with our readers, and we will await their decision.

NEW OXYGEN PLANT

In these days of general industrial improvement it is refreshing to note the spirit of optimism evidenced in the announcement recently authorized, that the Dominion Oxygen Company, Limited, will break ground in mid-July for a new quarter-of-a-million-dollar oxygen plant at Montreal, which will double the company's present capacity. The building will be 100 ft. x 100 ft., and will be substantially a duplicate of the Company's Toronto plant, which until now has supplied oxygen to Canadian industrial users through five district distributing stations. The Montreal plant will be the second of five producing plants projected at the time the company was organized last year.



ACTUAL CARDS FROM COMPOUND ENGINE.

Boiler Accessories from a Safety View Point

The Author Considers the Various Mountings of the Modern Boiler, and Suggestions are Made for the Greater Safety of the Boiler Room Operator and Attendants.

Being without knowledge of the difference between accessories, apparatus, appliances, and fittings, as applied to steam boilers, I have selected a few of those devices which I consider accessories, and have treated each in the order of their seeming importance.

Safety Valves.—There should be at least two safety valves on every steam boiler, for the reason that if only one valve is provided it may fail. It is evident that if there are two or more safety valves there will be less likelihood of excess pressure being raised on the boiler than if one only is used. We are assuming that the combined capacity of the valves is proper and in accordance with modern standards.

The question of mounting the valves on a Y or other base, the single outlet of which connects with the boiler has been frequently debated upon, and apparently there is no objection to the Y-base.

It is difficult to mention safety features of the valve itself which have not already been taken care of by manufacturers of approved valves. When the valves are constructed of approved materials, equipped with the correct spring for the pressure to be carried, and have the desired angle of disc and seat, there is little further to be said, except that there must be an easily accessible means of lifting the disc from the seat for testing purposes, "easily accessible means " to be interpreted as indicating that the attendant must be able to lift the disc from the seat while the boiler is under pressure, without danger of burns on hot parts, without having to grope about for a cord or lever, without climbing a ladder, and, preferably, from a point when the pressure-gauge and the water-gauge glass can be viewed while the disc is being held off its seat. In operating practice it too frequently occurs that the boilers are being worked beyond normal rated capacity, and if the water chances to be quite high in the boiler, the lifting of the disc when the gauge pressure is up to within a pound or two of the blowing point may cause water to be carrid into the steam line. If both the pressure-gauge and the water-gauge glass are visible from the point where the disc may be raised, the action of the water in the glass will very often indicate to the attendant whether the disc should be instantly dropped or whether it is safe to hold it open for a few seconds. Theoretically, the lifting of the disc under any conditions will not cause water to be carried into the steam line, but in practice this frequently occurs. Where the boiler load is intermittent, which is also a frequent occurrence it is often necessary to carry the water very high in the boiler during periods of the lesser steam demands, in order that when greater steam demands are suddenly made it will not be necessary to pump feed-water rapidly into the vessel, thus making it more difficult to maintain the necessary steam pressure.

The discharge outlets of the safety valves should, of course, be so arranged that there will be no likelihood of any person being scalded, or having dust blown into his face and eyes, when the safety valves open, but it is not desirable that the outlet should be piped farther than absolutely necessary. The piping should be as straight as possible and with no more than one bend or elbow in the line. The bend or elbow should be provided with at least a 1in. free drain at the lowest point, except that if the discharge outlet is less than 1in., then the drain need not be so large.There are cases on record where persons have been scalded by safety-valve discharge, and also where severe eye injuries have resulted from dust on the boiler tops being blown into the eyes of attendants. In some plants a ¾in. pop valve is installed on each boiler, and set 2lb. or 3lb. lighter than the main safety valves. The blowing of this pilot valve, which makes considerable noise, is a warning to the attendants that the main valves are about to blow, and I am not sure that it is not a good idea to place pilot safety valves on every boiler, for the expense is not considerable, and there is, no doubt, an advantage in knowing that the main valves are about to blow.

Water-gauge Glass.—It is generally conceded that the gauge glass should be provided with a guard to prevent flying particles of broken glass from striking the attendants, but it is not easy to obtain guards which will leave a free and un-obstructed view of the water level when the water column is located 10ft. or 15ft. above the boiler room floor. This is not an uncommon height on several types of boilers. Gauge glass guards of a suitable and efficient nature are limited to a very few, and unless the purchaser chances to select one of these few, the result is dissatisfaction and the discarding of the guard. Since the breaking of the gauge glass is a common, expected, and unavoidable occurrence, and since many severe injuries have been received from flying particles of glass, it is evident that operators should make every effort to secure a proper guard, and be willing to experiment to some extent in the endeavour to get one which is efficient and at the same time does not obstruct the view of the water level.

The newer forms of connections for the gauge glass permit considerable misalignment of the glass and more expansion than the types heretofore used, so that glasses will be breaking less frequently; but no device, other than a guard around the glass itself, may be expected to eliminate the danger incident to a breaking glass. Until very recently the tightening of the gauge-glass gasket was done by revolving a hexagonal nut. The action of revolving this nut put a considerable twisting strain on the glass. In addition to this valuable form of the ordinary packing gland and follower, and puts no twisting strain on the glass. In addition to this valuable feature, it permits great misalignment of the glass. The only. safe gauge-glass valve is the quick-opening chain-operated type, which permits the operator to stand some distance from the glass and control the line of steam and water to it by merely pulling on one of two chains, either to open or to close the valves as may be required. With the screw type of gauge-glass valve it is necessary for the operator in opening and closing the valve to expose himself to the danger of a glass breaking, and the exposure is for a considerable length of time, since it takes considerable time either to open or to close the two valves.

Gauge Cocks. — The non-thread weighted or self-closing gauge cocks have many advantages over the screw type, and can be used to more advantage in a great number of places than the screw type, the latter being improper for any condition except locomotive work, where the vibration and jar are so great that the screw type is better. The only reason that the self-closing type has not met with more favour is because attendants will not give them the attention to which they are entitled, with the result that they leak. With reasonable care—and it is expected that all mechanical equipment should have this—the self-closing gauge cock will outlast any other, is far safer than the screw type, and the attendants using them are in no danger of being scalded through causes attributable to the type of valve; whereas, with the screw type, scalding is not uncommon. There are cases where the valve was screwed entirely out, thus allowing a stream of hot water to discharge from the valve opening, with no way to stop it except to relieve the boiler of all pressure.

Water Columns.—The columns of many of the older installations are frequently of insufficient capacity, and while, theoretically, water seeks its

own level, it is a fact that the gauge glass frequently shows a false water level where the column capacity is too small, and the installation of a modern type of column and its equipment is a good investment for any boiler-user who may at present be using the older types of small columns, scarcely larger in internal diameter than the pipes to which they connect. Obviously, since the purpose of the column is to show a still water level in the boiler, it follows that it should be of sufficient capacity to ensure the least possible agitation. The difference of opinion as to whether the column connection should be equipped with stop-valves is considerable, but there is scarcely greater excuse for stop-valves on the water-column connections than there is for stop-valves between the safety valve and boiler, and the water-column stop-valves will eventually be closed at a time when they should be open; at least, we are led to that conclusion when we remember that it is always the unloaded gun which kills. It is admitted that there are advantages in having stop-valves on the water-column connections, especially in territories where boiler-feed water is quite bad, for water with considerable solid in it causes accumulations of this solid, whatever it may be in and on the parts of the gauge cocks, with the result that they leak more or less. With the stop-valves in the water-column connections the column may be shut off and the valves repaired without blowing down the boiler. I think, though, that the disadvantages of having the stop-valves outweigh the advantages.

High and Low-water Alarms.—These alarms have their advantages, but they also have their disadvantages. In my opinion they should not be used, for the simple reason that attendants invariably come to rely solely on the automatic action of the alarms, with the result that frequently the water level runs dangerosuly low, through failure of the alarm, and it would seem that the attendant should not have duties sufficiently multitudinous to prevent him from properly watching the water level through the gauge glass and the testing of the gauge cocks.

Pressure Gauges.—These instruments, as a rule, do not cause accidents, and yet, if they are not equipped with a siphon in the form of a loop or U-bend, the tube will shortly harden and cause the gauge hand to show improper reading.

Blow-off.—A common danger which has, without any good reason, existed for many years exists in the use of a 2½in.-diameter blow-off pipe on certain types of water-tube boilers. The type referred to has a drum capacity of about 44 cub. ft., and, under average conditions, the drum would be half filled with water during normal operation —that is, there would be, roughly,20 to 25 cub. ft. of water in the drum. With 160lb. gauge pressure, which is the normal pressure for the type, it is possible to blow all the water out of the drum in between 8secs. and 10secs., which means that even with quick opening and closing blow-off valves the attendant would have great difficulty in properly blowing the boiler down without blowing out so much water as to leave the drum and certain of the tubes empty and exposed to the hot furnace gases. It is strange that the manufacturer, the user, and the multitude of inspectors do not realise this danger and reduce the diameter of the blow-off thus create a dangerous condition. Our boiler codes give us the minimum and maximum diameter of the blow-off pipe without taking into account the cubical capacity of the boiler. The size of the blow-off equipment on fire-tube boilers is seldom found to be too great. Attendants soon learn that they cannot, with safety, open the blow-off valve wide when blowing down, so they adopt the practice of opening it only part way, the result being that proper blowing down is not accomplished, and sediment lodges in the valve, causes various inconveniences, expensive repairs, and danger.

It seems desirable that the code should take into account the proper area of blow-off pipe with relation to the pressure carried, and the cubical contents of the boiler between normal water level and the lowest safe water level.

Non-return Valves.—Among many pipe to 1½in., which would be ample for the particular type referred to. A boiler with less than 75 cub. ft. of water between the point registered by the centre of the gauge glass and the highest point of contact with the furnace gases, and carrying a pressure of 160lb., should have a blow-off pipe no greater than 2in. in diameter. With any larger diameter the proper blowing down of the boiler will lower the water level to below the highest point of the gases and dangerous practices continually going on, at least two stand out. While they are not related to each other, they seem to exist pretty well together in power-station work. The one is the synchronising of two alternators by guess— that is, by watching the effect of the current alternations on an incandescent lamp. The other is the cutting in of a boiler on a header which is being supplied by other boilers. The guesswork on synchronising not infrequently throws the whole system out of step, and the guessing of the proper time to open the stop valve from boiler to header sometimes results in disastrous explosions. In the first case, a very simple and inexpensive synchronising indicator is purchasable and reliable. In the second instance, a much cheaper and simpler device, in the form of a non-return valve, is procurable which will not only prevent the boiler from being cut into the line too soon,but will protect the entire system in the event of a tube bursting in one boiler. Non-return valves are a necessity, but education of the user into the necessities of having non-return-valves is an inordinately slow process. If it is not beyond the jurisdiction of the boiler to deal with non-return valves, then certainly the code should be used on every boiler connecting to a header with one or more other boilers.

Rotary Tube Cleaners.—Rotary tube cleaners, motor or turbine driven, are the only mechanical means for cleaning the interiors of tubes of water-tube boilers. With curved tubes, the cleaner, in its effort to follow a straight line through the curved tube, more or less rapidly wears away the metal of the tube at certain points near the bends, and not infrequently the tubes are so thinned by the cleaner that they burst during operation. There is no object in running the cleaner through the tubes until there is some scale present. The greater the amount of scale the slower the cleaner will travel through the tube, and, since the rotary speed of the cleaner is constant, it follows that if it stands still, or practically still, at any one point in the tube, and its cutting parts continue to revolve, a spot in the tube will be worn by the cutters. The extent of this wearing cannot be determined by any process of inspection; therefore a danger is present, the character of which makes it highly advisable that the boiler washer be most carefully instructed in the proper use of the cleaner, having the dangers of improper use explained to him, and further advisable that tubes which are apparently still good should be cut out at certain intervals, depending upon the frequency of the use of the cleaner, and replaced with new ones; the old being examined to determine the remaining thickness. Steam-turbine cleaners have an added danger of the steam hose bursting, and this hose, in addition to being wire-wound, should be discarded and replaced with a new one at least twice each year, regardless of the amount of actual use, for both the rubber and the fabric used in the manufacture of the hose deteriorate with age, and bursting steam hose has caused a great number of very serious accidents.

Concrete Floors Under Boilers.— If concrete floors are not accessories, they nevertheless deserve comment when they form the bottom of the ashpit and combustion chamber of any type of boiler, in localities where the atmospheric temperature reaches or falls below the freezing point. A substantial concrete floor laid on clay, or almost any soil other than dry sand, becomes dangerous when heated through to a temperature of more than 212 degrees F., for the moisture which collects under the floor is converted into steam by the heat, and there is probability of the floor being burst with great violence, due to the pressure under it. There are records of

accidents resulting from what amounted to an explosion of the floor, caused by steam pressure forming under it, and, quite naturally, before a substantial floor can be burst by steam pressure, acting upward under it, pressure must be quite high; it just as naturally follows that this high pressure, when instantaneously released,must be expected to do considerable damage in the immediate vicinity.The specifying engineer of boiler installations should, therefore, take into account the dangers connected with the use of concrete floors under boilers, when such floors are laid on soil which will not permit any steam formed under the floor to travel downward before the pressure generated reaches anything substantially above atmospheric.

Furnace-door Locks.—There have been a number of accidents to boiler attendants, in the nature of scalds and hot-fuel burns, resulting when bursting tubes or flues push open the fire or ashpit doors and allow steam and live coals to pass into the boiler room, at a point where the attendant may be expected to be stationed. A great many, if not all, of these accidents could have been prevented by the installation of automatic door-locks, types of which are now on the market, and which, when the doors are even somewhat carelessly closed by the attendants, still lock, so that no amount of pressure inside the furnace or ashpit will throw the doors open. The objection to installation of locks is frequently that if the lock is so substantial that it will not break and allow the door to open, then the pressure which would, without the door-lock, open the door and be relieved, must then blow out the boiler walls. The proper attitude, however, is to consider that the safety of the attendant is the first consideration; if it is necessary to sacrifice a part of a boiler wall to save the attendant's life, then the wall should be sacrificed. It does not follow, however, that the boiler walls will be blown out by a tube explosion, in the event of the furnace and ashpit doors being locked, though admittedly, if a 4in. tube in a water-tube boiler carrying 160lb. pressure, burst along 1ft. or 2ft. of its length, there will momentarily be a considerable pressure in the fire and gas passages; this pressure may, if the doors are locked, blow down a portion of the boiler walls or lift off the top cover. There are perhaps no more than one or two inexpensive, yet reliable, door-locks manufactured, and the reluctance of the operators to install locks is caused to some extent by the failure of some of the makeshifts which have been installed, but all of those having opportunity to do so should prevail upon operators to install approved furnace- and ashpit-door locks.

Steam-flow Meter.—This valuable device has not met with the welcome reception to which it is entitled, and there is probably no good reason why every boiler operating in a battery with one or more other boilers should not be equipped with a steam-flow meter which will be a positive indication to the fireman that each boiler is, or is not delivering through its steam line its proper proportion of steam.

In any battery of boilers, even when each boiler has precisely the same theoretical capacity as its fellows,there will be one or more either delivering less steam or more steam than it should deliver, and this inefficient and rather dangerous condition is instantly detected by the reading of the steam-flow meter. The increasing or decreasing of the fire intensity can immediately be accomplished to exactly the degree required for the boiler to do its proportion of steaming. Perhaps the safety features of a steam-flow meter are greatly outweighed by their efficiency features. Nevertheless, there is less danger present in the operation of a battery of boilers when each boiler is doing its proper portion of the work than when one or more boilers are doing much more or much less than its share of the work; the danger lying in the probabilities of burning the tubes or sheets of the boilers which are over-fired, and the danger of low water in the same boilers and excess water in the under-fired boilers. These statements do not take into account the ideal condition of boiler operation, which is seldom realised, but instead contemplate average working conditions where some scale is present and where all boilers are fed through a common source.

Oil Burners.—All steam or air atomised oil burners are in themselves dangerous or the equipment necessarily used in connection with them becomes dangerous through their use. Mechanical atomisation is reasonably safe. Since mechanical atomisation is more economical, by a considerable margin, than steam or air atomisation, it may be expected that sooner or later all atomisation will be done by mechanical process to the complete exclusion of the steam or air process. The most economical steam atomiser oil burner will require from 2 to 4 per cent of the steam generated in the boiler for atomisation of the fuel oil, whereas mechanical atomisers use none of the power generated by the boiler,exclusively of that required to pump the oil to a given pressure and furnish heat for it, and this power is also required with the steam atomiser. With steam atomisation, carbonisation takes place at the burner tip resulting in an unequal spread of the fire, and this, in addition to reducing efficiency, produces a danger, in that it frequently causes the fire to concentrate upon one or more relatively small areas on the tubes or sheets, causing burns and bags.

This condition does not exist with mechanical atomisation. The steam or air atomiser will be set to atomise the oil properly at a given boiler pressure, which, let us say, is 10lb. lower than the desired boiler pressure. The attendant regulates the burner to increase the boiler by 10lb. The multitudinous duhim to some refractory boiler-feed pump, or elsewhere, and while he is busy for five minutes the steam on the boiler increases the desired 10lb., with the reties of the average attendant call sult that the atomiser valve will pass more steam to the burner than is desirable, and literally blow the fire out. After a few seconds, a quart or more of crude oil has entered the furnace, and since there is no flame present, the hot bricks generate explosive gas from the oil. The gas explodes.

Such a condition is altogether unlikely with mechanical atomisation. The one possible objection to mechanical atomisation is the necessity for bringing the oil to a high temperature before it enters the burner. The temperature is necessary to reduce the oil from a heavy to a light condition, and it seems to be the practice to heat the oil to 250 degrees or 275 degrees F., yet I have learned of no accidents attributable to bringing the oil to a Fahrenheit temperature of 275 degrees. Careful damper regulation is paramountly necessary when oil fuel is used. If the attendant is burning coal and forgets to open the damper before firing-up after a short or long shut-down, there may or may not be an explosion of confined coal gas, but with oil fuel it is extremely dangerous to start the fire or admit any oil to the furnace until after the damper may have been opened at least a few seconds, for fuel oil is converted into gas very quickly by relatively low temperatures, and the explosive power of the gas is considerable, so unless the damper is opened wide before oil is admitted to the furnace, an explosion of violence is apt to occur, and not merely blow down a portion of the boiler walls, but injure the attendants.

Explosions of Gases in Fireboxes.—Burns from hot gases passing through the furnace doors into the boiler room are rather too common. These burns are not always caused by explosion of furnace gas, but the person burned and those who may make a perfunctory examination into the case are apt to state that there was an explosion of gas in the furnace.

If a boiler is manually fired and has a thick, long flame, the fire burning with a strong draught, and if, for any reason, the damper is suddenly closed, hot gases and the flames themselves frequently pass through the furnace doors in the fire room, and any person in line with the fire door, and no more than 3 ft. or 4 ft. away from it, is apt to be burned, whether he is actually attending to the fire or whether the door was closed.

The sudden closing of the damper is something which does not frequently take place accidentally, although there are one or two types of damper regulators, which, under certain conditions of bad repair, permit a rather rapi

closing of the damper. None of these regulators, if in good repair, will close the damper rapidly enough to cause flame and hot gases to pass into the boiler room.

Many of the burns from hot gases which pass into the fire room through causes other than the furnace explosions, have been traced to the sudden closing of a manually operated damper, weighted in a manner to hold the damper closed, and it is good practice, therefore, to weight a damper in such a manner and so heavily that the damper will open itself. When this is done, danger of the damper accidentally being closed is very slight, and any one of many simple contrivances can be arranged to hold the damper in the closed or any intermediate position against the tendency of the weight to open it.

If a shovelful of very wet coal and as much as a quart of free water is thrown upon a red or black fire, a considerable explosion is apt to result from the water gas which is instantly formed and ignited, so evidently it is bad practice to stand in front of the furnace door and throw in wet coal and unabsorbed water.

If the damper is partly closed, as is frequently the case in normal operation, to prevent too rapid combustion, any exploding gas in the firebox will be more dangerous to the attendant in front of the fire doors than the same amount of gas would be with the damper wide open.

Where the steam blowers are used for forced draught, there is generally considerable piping between the original source of steam and the blower valve. If the blower is not in constant use, condensation takes place in the supply pipe and considerable water accumulates. The opening of the blower valve permits the water in the pipe to be suddenly projected into the ashpit, where the temperature, under many normal conditions, may be well over 225 degrees or 250 degrees F., and while I am not prepared to say why the explosion should take place in the ashpit, it nevertheless is a fact that this has occurred, burning an attendant severely. Although it may seem that to install a steam trap immediately above the blower valve is an over-precautionary measure, there is at least one case on record which would seem to justify such an installation.

I do not personally know of any instance where the attendant was burned when he opened the furnace door at a time when forced draught was being caused by a steam blower into the ashpit, but I have heard of such cases, and believe they occur. The precaution of providing an interlocking device on the furnace door which will shut-off the blower before the door can be fully unlatched, and which I understand has been adopted in some of the plants of the Du Pont Company, is a valuable one, and its value should undoubtedly be brought to the attention of every user of forced draught, whether the draught is caused by a steam blower or a fan. It is conceivable that the arrangement could be cheaply and satisfactorily installed, and, as long as it was kept in order, would positively prevent the evident danger.

It is thought by some, and I believe not without basis, that the opening of a furnace door, and the resultant admittance of air to the firebox, cause explosion of gases which have accumulated in the space above the fire, even though the damper may be open. It is difficult to see how any considerable quantity of gas would accumulate and remain in the firebox when the damper is open; yet, apparently, such conditions have existed.

A good many householders who burn coal in some sort of furnace, such as the hot-air type, will have at some time noticed that after filling up the furnace with fresh coal for overnight banking purposes, all flame disappears, and in 5 or 10 mins., if the furnace door is opened and a rush of air is caused to enter the furnace door by fanning across the space with a newspaper, or even by blowing into the furnace, there will be a sudden burst of flame up through the coal. While it is not in the nature of an explosion, it is conceivable that if the fire area were large, as it is in the case of steam boilers, and the quantity of coal proportionately large, then the sudden bursting into flame would take the appearance of an explosion.

The only safety measures which suggest themselves to me in connection with prevention of furnace gas explosion, or injuries resulting from unpreventable explosions are, first, the providing of a proper latch for the furnace door, and, second, the careful education of the firemen in how to perform their duties.

*Paper delivered before the Engineering Section of the National Safety Council at Philadelphia.

A BRITISH DISCOVERY RE-DISCOVERED

Great interest was caused recently in London by a demonstration, given before the Institution of Electrical Engineers, of a strange phenomenon alleged to be absolutely new to science. When an electric current is passed through a half-conducting material, such as lithographic stone, in close contact with a metal, the metal and the stone stick together with a force which is out of proportion to the strength of the current passing from one to the other. The demonstrators, who came from Scandinavia, showed how this phenomenon could be applied in making a loud-speaking telephone. By its help they made a violin reproduce music played in a distant room and "speak" words spoken into a distant telephone transmitter. This demonstration was, however, followed very soon by proof that the phenomenon had been discovered many years before in Great Britain and its application to telephony had actually been described before learned societies and in a popular encyclopedia. The discovery in Scandinavia was therefore a re-discovery and the incident suggests that the past records of British research and invention may contain more hidden items capable of practical development in the light of the fuller knowledge now available.

AN ALL OIL NAVY

Naval experts and shipbuilders in all parts of the world have been impressed by the decision of the British Admiralty to build only oil-burning ships in future. Many reasons have combined to bring about this decision. Among them are the convenience of transporting oil and storing it at strategic points, the small space which it occupies on board ship, the ease with which oil may be taken on board ship from tanks or tank steamers, the simplification of stoking, and the high efficiency of the fuel. It is calculated that even at present prices oil is cheaper than coal as a fuel, apart from the other economies enumerated. This official decision is likely to give a fillip to the movement, already taking place rapidly, for the conversion of large liners and other merchant vessels flying the British flag from coal-firing to oil-firing. One benefit of the change will be to do away with the terrible conditions to which stokers on coal-fired ships are subjected, especially on tropical seas. On humanitarian grounds alone the example of British enterprise in this direction is worthy of world-wide adoption.

To every user of engines driven by crude oil, the process of starting is a nightmare. The blow lamp by means of which the fuel spray is usually given its initial heat, is a device with an almost Satanic cussedness of behaviour. Moreover its use involves a considerable amount of time as well as trouble. Consequently there ought to be a wide welcome for an ingenious electric heater developed by a leading British firm of oil engine makers. The device is extremely simple. It consists essentially of an electric heating element of high resistance wire placed in the line of action of the oil spray. A small amount of current suffices to make this wire white hot, in which condition it brings the spray rapidly to the temperature required for starting. After the engine has gone ahead the element is withdrawn, so that it is not exposed for more than a minute or so to the high temperature of the combustion chamber,—an arrangement which gives it long life and great reliability. The electric current required for operating the heater is supplied by a 4-volt or a 6-volt battery charged from a tiny electric generator, driven through a belt from the engine. By means of this device the engine can be quickly started up from cold without the slightest trouble. Twelve months trial of the apparatus has shown it to be thoroughly satisfactory.

Overhauling and Adjusting in the Engine Room

Following the Course of Previous Articles, in This Instalment the Valve Gear of the "Cameron" Pump is Illustrated and Described. This Gear Has Some Good Points Which Are Defined.

By "FITTER"

IN THE last issue of "Power House" we illustrated the steam valve and gear of the Darling pump, and we now take up another simplex type of pump also made in Canada, and employing a different method of operating the steam valve. The principle is of course the same in all simplex pumps, that is the main valve is moved from side to side by an auxiliary valve, but the method of moving the auxiliary valve varies in different pumps.

The Cameron Pump

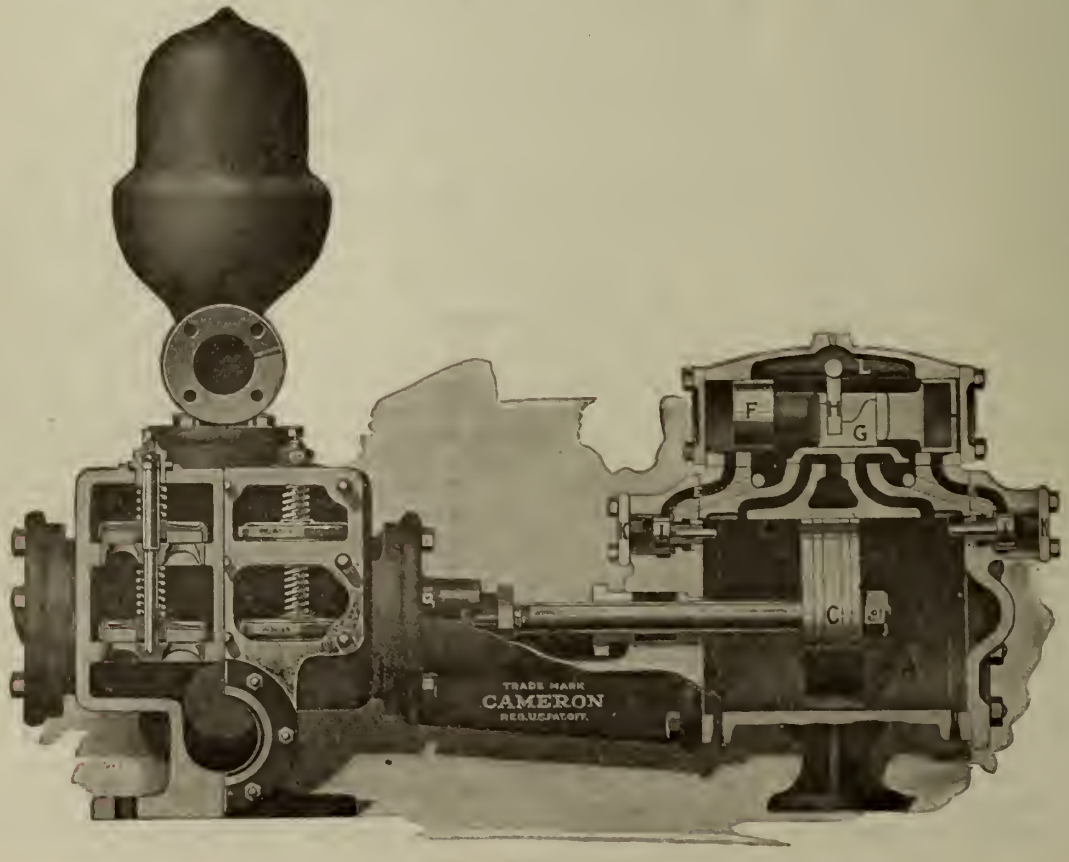
The "Cameron" pump is illustrated in the accompanying cut, which shows very clearly the method of operating the valve. In this case there is no spool on the rod, and no spindle projecting from the valve chest, and no levers of any kind on the outside of the pump.

Referring to the cut, it will be noticed that the slide valve G is of somewhat different construction to the ordinary slide valve, there being a division in the centre, which performs the function of closing the exhaust cavity off from the steam port as the valve moves from end to end. Looking above the slide valve, the auxiliary valve F is shown partly in section and partly in elevation. This enables us to observe plainly the construction of this valve. It is really formed like a piston valve, the ends of the piston being hollow, as can be seen having a small outlet as shown. The hollow piston being filled with steam the steam escapes through this small outlet and fills the clearance space between the valve and the valve chest cover with steam, thus making the valve in a state of equilibrium, with no tendency to move in either direction.

Referring again to the cut, it will be noticed that there are two small pistons or plungers at each end of the steam cylinder marked I I, and that the spindles or rods of the small pistons project into the steam cylinder. These pistons are covering when in their normal position the port E at each end of the cylinder and these ports communicate with the chest in which the auxiliary valve is working. In addition to these ports E, there can be seen two smaller ports which are shown in dotted lines, and which lead from the main steam chest to the back of the small pistons I I and thus tend to keep these pistons always over the ports E E. The side valve G is attached to the auxiliary valve by a lug which causes the slide valve to be driven in the same direction as the auxiliary valve. This lever H extends through the steam chest, and on the outside of the chest a handle is attached, which enables the auxiliary valve to be moved by hand before starting up the pump, or for placing the piston in a desired position.

The Operation

The operation of the valve can now be followed from the illustration. Looking at the cut we see that the piston is receiving steam at the back side and is therefore moving on the out stroke, or towards the water end of the pump. The other side of the piston is open to the exhaust through the slide valve G. The auxiliary valve is at the extreme end of its stroke towards the back end of the cylinder, and in this position the port E is covered by the hollow piston, of the valve, and also by the small plunger I. so that it is completely closed off. At the other end the port E is closed off by the plunger I alone. As the piston goes forward, and approaches the end of its stroke it will come in contact with the rod or spindle of the plunger I forcing it forward against the pressure of the steam and opening the port E. to the cylinder, which is in communication with the exhaust. The result is that the steam in the clearance space between the end of the auxiliary valve and the auxiliary steam chest cover, is exhausted, which



THE CAMERON PUMP

causes an excess of pressure on the other side of the valve, and it is thrown over to the opposite side of the chest taking the slide valve G with it and thus reversing the motion of the piston. This is an absolutely positive action, and the reversal of motion is absolutely bound to occur when the piston touches the small plunger I, which is called the reverse valve.

The reverse valve spindle is made sufficiently long to ensure a certain amount of steam being retained in the cylinder to allow for cushioning, and it will be noticed that before the piston reaches the reverse valve it has already covered the main opening of the exhaust port, though there is still a small orifice left to allow the steam from the port E to escape. Thus the piston performs its own cushioning in this as in most pumps, and the motion of the auxiliary valve is also controlled by the same principle. The piston end of the auxiliary valve as can be seen covers the port E before the valve reaches the end of the clearance space.

Maintenance.

It can be clearly seen that in this motion there are a minimum of moving parts, and great simplicity in the port castings. The only moving parts are the auxiliary valve F, the main valve G, and the two small plungers I I. There is but little wear, as the movement of the valves is very slight, they being at rest during a portion of the stroke, while the auxiliary valve moves with a minimum of friction. The absence of valves spindles protruding through the chest makes less glands to be packed than are usual the only gland being that on the main piston rod. The cut shows plainly the construction of the water end of the pump. These pumps have been used largely in mining work as well as stationary practice.

Universal Craftsmen's Council of Engineers

This Body of Stationary Engineers Who Are Also Members of the Masonic Order, Will Hold Their Convention From August 2 to August 6 in Toronto, at the King Edward Hotel.

TORONTO has been chosen as the scene of the 19th annual Convention of the Universal Craftsmen's Council of Engineers, a body composed of engineers who are also members of the Masonic Fraternity. The organization is a strong one in the United States and is a growing one in Canada, there being two councils in Toronto, one in Hamilton, which was recently formed, while the cities of Winnipeg and Brandon each have one. Montreal is expected very shortly to be added to the list of Canadian centres of this order.

Needless to say, there has been a vast amount of work in connection with this convention, and it has been handled in its entirety by the local committee, the chairman of which is Mr. L. J. Cudbird, Chief Engineer of the Toronto City Hall, and a Past Worthy Chief of the Toronto Council. He has been assisted in his efforts by the following committee:—

Harry Parker, D. D. G. W. C., Canada S. S. Lines—H. Potter, P. W. C., Hinds & Dawsch—W. Wolfenden, W. C., City Hall—J. Grimshaw, Administration Bldg. B. O. E.—W. Pike, King Edward Hotel—Geo. Aldridge, Bowser Pump Co.—R. Allman, W. C., Technical School—H. E. Terry, P. G. W. C., Continental Life Building—A. M. Wickens, D. D. G. W. C. Consulting Engineer—W. J. Hudson, P. W. C. , Coco Cola Co.—T. C. McAree A. C., Toronto Electric Light—Chas. Holmes, Boiler Inspection & Ins. Co.—L. Westwood, Prince George Hotel—Alex. Auchterlonie, Sick Children's Hospital, Wm. Watt, P. W. C., Swifts Abattoir.

The Power Exhibition

One of the features of the convention will be an exhibition of power plant supplies and accessories, and the following firms have secured space at the time of writing.—

Beldams Canadian Asbestos Co,	Booth 54
Crouse Hinds Co. of Canada Ltd	22
James Morrison Brass Mfg. Co.	28
Chapman Ball Bearing Co.	33
Canadian Jones Manville	
Kirby & Co.	17
Demco Machine Tool Co.	
Refinite Co. of Canada	
Superheater Co. of Canada	1 & 7
S.K.F. Ball Bearing Co.	2
Valve Engineering Co.	3
Otis Elevator Co.	6
Canadian Sirocco Co.	14
Republic Flow Meters	15
Engineering Specialties	4
Dearborn Drug & Chemical Co.	19
Jenkins Valve Co.	20
Underfeed Stoker Co. of Canada	24
C A. Dunham Co.	25
Powers Regulator Co.	26
J. H. Wenting	27
Crane Valve Co.	30
Allen General Supplies	37-8-9, 43-4-5
Wilson Packing Co.	42
Darling Bros.	55
W. R. Sexton	56
Taylor Instrument Co.	64
Lunkenheimer Valve Co.	67
Garlock Packing Co.	65
McColl Bros.	68
Hollow Centre Packing Co.	69
POWER HOUSE	70
Imperial Oil Co.	29
Black Donald Graphite	58
W. Cunningham Co.	13
Canadian Blower & Forge	31
Pierce Fuse Devoe Switch	21
Taylor & Arnold	34
Home Rubber Co.	9
Keystone Grease	53

The Entertainment Programme

A most interesting round of entertainments to vary the monotony of business has been arranged and it will be seen from the accompanying programme that neither trouble nor expense has been spared by the committee to ensure the visitors and their ladies having an enjoyable time. The programme is planned in such a way that all those attending will have an excellent opportunity to see the good points of the city. The space in which the exhibits will be shown ensures the best possibility of showing off the various accessories, and the visitors are enjoined on the programme to visit "Exhibition Hall,, The following is the programme in detail:—

Monday, August 1st

Informal reception of Delegates and Visitors

Tuesday, August 2nd

10 a. m.—Invocation, Rev. F. E. Powell.
Official Welcome by Chairman L. J. Cudbird and Chairlady Mrs. H. E. Terry.
Mayor of Toronto
Masonic Fraternity, R. W. Bro. E. M. Carleton.
Board of Trade, R. C. Harris, Com. of Works.
Noon—Opening Session of Grand Council.
1 p. m.—Opening of Exhibition
3 p. m.—Business Session.

Wednesday, August 3rd.

9.30 a. m.—Business Session
2.30 p. m.—Business Session
6.00 p. m.—Automobile Ride. Cars leave City Hall steps. NOTE—Those missing Auto Ride, take King Car to Sunnyside.
9 to 12 p. m.—Dance, Sunnyside Pavilion

Thursday, August 4th

9.30 a. m.—Business Session
2.00 p. m.—Picnic, Island Park. Games, Baseball, etc.
4.00 p.m.—Official Photograph at Island Park.

Friday, August 5th

11.00 a. m.—Memorial Services.
3.00 p. m.—Installation of Officers. Closing Session
8.00 p. m.—Banquet, King Edward Hotel.

Saturday, August 6th

SEEING TORONTO

The United States Gauge Co., New York, have issued their Catalogue No. 50 describing their complete line of pressure gauges for all purposes. Besides gauges of the usual type, vacuum gauges, tire testers, thermometers, and precision instruments in general are described and illustrated.

Member of the Audit Bureau of Circulation

POWER HOUSE

JULY 20th, 1921

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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THE ENGINEER IN THE DOG DAYS

WHILE the general public is going around mopping its perspiring brow and groaning about the heat, it is very doubtful if any of them ever give a thought to that portion of its people whose daily lives are led in what might be called zones of high temperature. Among these are the engineers in charge of the various steam power plants, in factories, office buildings, institutions etc. There is a great variation between plant and plant depending on whether it is on the ground level with ample window and door openings, for the circulation of air, or if it is situated in a basement with little natural light and less ventilation. There are any amount of engine rooms through the country where the temperature in these days will be from 100 degrees to 110 or higher, where men carry on over long shifts without fuss or complaint, merely taking things as they come. The casual visitor from the office who has occasion to go down to the engine room in these days, generally leaves it in a hurry, and goes back to his desk with the fan blowing on him, where he has been complaining of the terrific heat all day. The engine room staff must make their own repairs and keep the plant going, regardless of heat, and the fireman must stand in front of his fires and go through the soul roasting task of cleaning whether the thermometer is at 70 degrees or 100. The strange thing is that the average manager or head of a factory, while very much concerned about the comfort of the producing workers in the factory, rarely if ever gives a moment's thought to the comfort of those who are keeping the whole works running. In fact we are sorry to say that it has been our experience, that it is a matter of the greatest difficulty to secure small concessions or relaxations of rules for the benefit of the power plant staff during hot weather, and when such are granted it is with a very grudging spirit.

We would recommend those in authority in factories, institutions, etc. where there is a power plant to pay it a visit for a half hour or so on one of these hot days, and consider how they would like to spend a long day in that atmosphere, and perhaps return at night to do some job on top of the boiler, where the air is too hot almost to breathe. These things are all in the day's work for the stationary engineer, and he does them uncomplainingly, but we know there are moments when he would like to think that the powers that be realised the conditions under which he has to work. Very often these conditions could be much improved for a small expenditure, and this is where the management comes in, the improvement depending on the extent of the interest the management take in the comfort of their power plant staff.

A USEFUL INVESTIGATION

THE University of Illinois, which has done some valuable work through the medium of its Engineering Experiment Station, is now engaged on an investigation of the hot air furnace and system of heating. This is being carried out in co-operation with the National Warm Air Heating and Ventilating Association, and should be productive of good results. In order that the results obtained from the experiments should be of use in practical problems, a plant has been built which operates under the exact conditions found in the ordinary hot air heating installation. The objects of the experiments are to determine a proper method of rating hot air furnaces, so that the proper size of furnace can be definitely selected for the service required, to determine methods of increasing the efficiency and capacity of furnace heating equipment, and generally to determine all unknown factors in connection with this type of heating plant.

There is no country in the world where more interest should be taken in domestic heating plants than in Canada, where they are very much in evidence for the greater part of the year, and where the householder has to go deep into his bank account every year, to purchase indifferent coal which he feeds to an inefficient furnace. Then if the weather gets really cold with a high wind he shivers anyway.

We have never been in a house in this country in the middle of the winter yet that was comfortable, and whether this was due to the bad building or the poor heating system or both, the effect was the same.

Most hot air furnaces are put into houses in a happy go lucky spirit, and very often they are cut down by the contractor as small as he possibly can, in order to save a bit more money. The actual requirements from a scientific point of view we do not beleive are ever considered. The result is a gross waste of fuel, without any degree of comfort, and if the experiments now going on can determine an absolutely correct way of determining the capacity of furnace required, and also a method of rating which will ensure the purchaser getting that capacity, the benefit to the people in general will be enormous. If in addition to this, the most efficient way of carrying piping from basement to rooms, the correct position of register, and the right type of insulation are determined, there will be a large saving in fuel consumption, and the money thus saved to the country will be available for investment in Canada, instead of being eaten up by U. S. exchange and freight charges. The house heating plant in its individual capacity may not look much, but multiplied by the hundreds of thousand of families that use them, it is an exceedingly large factor in the country's expenditure. When we consider that of the money spent thus for fuel, the householder gets probably 20 per cent of its value in heat, he should be interested in anything that tends to improve matters, along these lines.

TORONTO NO 1. C. A. S. E.

A meeting of the above Lodge was held in the Lodge Room Temple Building on July 13th at 8 P. M. Following the usual business of the lodge, and the initiation of two new members, the lecture on Green's Economiser which had been postponed from the last meeting, was given. Notwithstanding the hot weather, and the uncomfortable temperature of the Lodge room, a fair number of the members stayed to hear the lecture, and evinced their interest by the questions they asked at the conclusion of the talk.

Progress in New Equipment

NEW IDEAL PUMP GOVERNOR.

The Ideal Pump Governor, well known in marine circles, has been redesigned. It is now manufactured solely by the Atlas Valve Company, Newark, N. J., whose designing engineers are responsible for the improvements made.

Figs. 1 and 2 show the two principal designs, called Style "A" and Style "B" respectively. Both of these are made for turbine or reciprocating steam-driven pumps. Both styles, also, are approved by the National Board of Supervising Inspectors of Steam Vessels and by the Bureau of Engineering, U. S. Navy Department. Style "A" (Fig. 1) is designed for constant or fixed pressures, whereas Style "B" is made for pressures that may be varied from time to time.

Style "B" (Fig. 2) is equipped with an emergency control lever which provides means for manually operating the governor so that it can be held wide open or be shut off tight, regardless of the pump pressure. Where the pump must deliver an exceptionally high pressure during an emergency, or where pumps must be shut down quickly in case of fire or rupture of the pipe lines, it is evident that this lever adjusting feature is important. It is ready at all times to throw the pump in or out of service as the emergency may require.

This pump governor is of the variable pressure type which can be adjusted to maintain any predetermined pump discharge pressure. At the same time by manipulating the lever an almost instantaneously increased discharge pressure is effected.

The Ideal Governor is piston actuated. It is extremely sensitive, with a patented exclusive feature of an actuating piston operating in a bath of oil. This body of oil not only lubricates the operating piston, but also prevents the liquid being pumped from entering the control cylinder, thus eliminating any possibility of the sticking of the piston due to corrosion, sediment.

The Ideal Governor is very simple in construction and consists of only two moving parts—the steam valve which moves backward and forward within the valve body (which is of the double seated balanced valve type), and the control piston which moves backward and forward in a bath of oil within the control cylinder. There are no diaphragms, cup leather packings or small delicate parts to get out of order.

These governors are installed in the feed line to the pump in a manner as indicated in Fig. 3. Fig. 3 shows Style "A" in place, hence the pump is a constant pressure pump. The control cylinder of this governor is connected through valve "A" and a pipe line to the pump discharge as plainly shown in Fig. 3.

For general use, from three-eighths to two-inch sizes, these governors are made of bronze throughout and for larger sizes up to six-inch they are given iron bodies, trimmed with bronze. For superheated steam they are furnished with steel bodies and monel metal seats and stems.

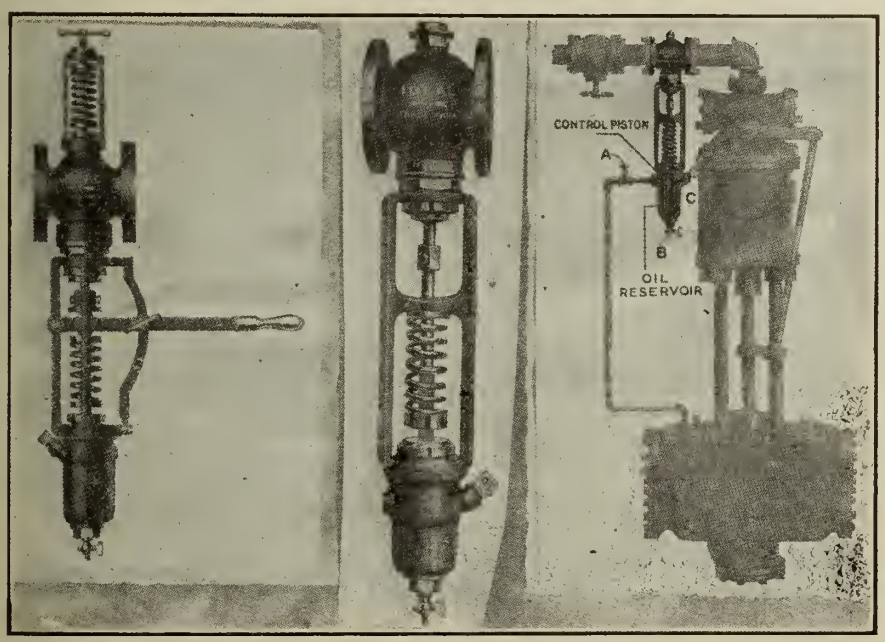


FIG 2 FIG 1 FIG 3

THE PERFECT WIRE ROPE

To a large extent the user of wire ropes must take them on trust—or, at least, on the faith inspired by the maker's name. And few of them can have any notion of the elaborate and detailed care taken to ensure that a wire rope will not murderously betray the men depending upon its strength at sea, in mines, or on constructional work. The policy adopted by one of the leading British makers of wire ropes will, however, serve to illustrate the fact that there is much more in a wire rope than meets the eye. To begin with, the firm produces all the component parts of the rope from the raw materials in its own factory. It therefore has direct control of everything from A. to Z. The steel for the wire is made in the firm's own steel works and is carefully tested to make sure that it is of the exact quality required A sample of every "melt" of steel is chemically analysed, and the analysis is filed so that the makers know the precise composition of the steel in every piece of rope that goes out of the factory. All the wire is drawn from steel which passes the test, and it is carefully galvanized. In the laboratory photographs are taken under the microscope to reveal the structure of every piece of wire. Before any coil of wire is used for rope making it has to go through rigid pulling, bending and twisting tests, winding up with a test in which a length of wire is made into a snarl and straightened out again and again until breakage takes place. Many wire ropes have a hempen core to give them greater flexibility, and in making this core the same patient care and supervision are exercised.

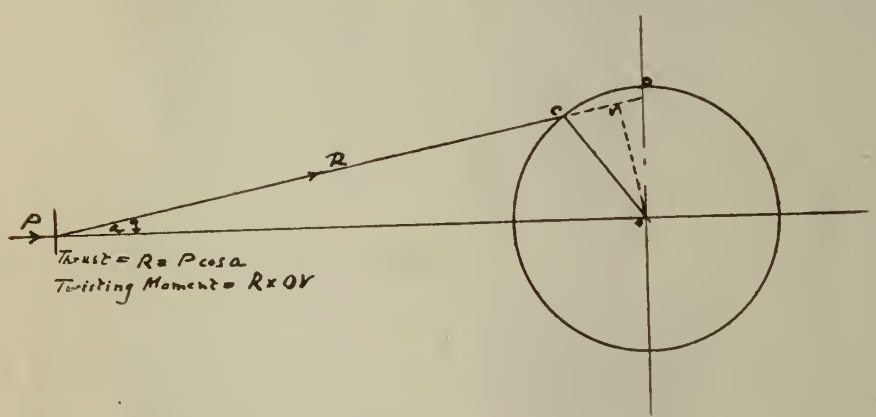
OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

THRUST IN CONNECTING ROD

Mathematics is conceded to be an exact science, and in its application to engineering problems it has need to be, as a good deal depends on it.

In the Question Box for Jan. 20 it is stated that the thrust on the connecting rod equals the total pressure on the piston rod x cos. ang. When the crank is off the centre this would make the thrust on the connecting rod less than the total pressure on the piston. In the Question Box of Feb 20. the thrust in the connecting rod is again stated to be less than the total pressure on the piston. In the Question Box of March 20 is a diagram which might represent the connecting rod crank and centre line of an engine with the crank at right angles to the centre line, and on the opposite page is a statement that "Power House" solves the problem.



SHOWING THRUST IN CONNECTING ROD

The diagram in question forms a right angle triangle and it it stated that the hypotenuse is greater than either of the two sides, which seems to me to be correct, but it differs from the statement made in the other two cases. In graphic statics we are taught that lines may be used to represent forces in both direction and magnitude and if the lines can be arranged to form a closed figure the forces will be in equilibrium, and any side of the figure will be the equilibriant of all the others. If this is true we may represent the forces in the connecting rod crank and piston as in Question Box of March 20. This will make the thrust in the connecting rod, or total pressure on the crank pin greater than the total pressure on the piston.

To some this will seem a paradox, but that is what paradoxes are for. It appears to me that the mistake (if there is one) in the January and February numbers consists in calculating the thrust in the connecting rod as the total pressure on the piston x cos. a, instead of total pressure on the piston x sec a, sec a being the reciprocal of cos. a. Some engineer will undoubtedly put me right if I am wrong.—R. McLaren.

Note :— Our correspondent's claim is that the force on the connecting rod is greater than that on the piston. Without going into any further explanation of a subject which has been well gone into, we might say that if this were the case, it would be impossible for the piston to turn the crank at all. On the other hand the connecting rod would push the piston back against the force of the steam in the cylinder.

We should be glad to hear from some of our readers who may be able to convince Mr. McLaren.

INJECTOR OR PUMP

Question:— Why are injectors not the most economical boiler feeder there is, considering that all the heat in the steam used is returned to the boiler, while a pump wastes it in exhaust?

Answer:— Considered purely from a thermal or heat point of view, the injector is highly efficient. Its efficiency as a pump is however very low. Further the pump can feed water that has been heated by exhaust steam that would otherwise have been wasted, while the injector can handle only cold or moderately warm water. The duty of an injector, which is reckoned by the foot pounds of work done per million heat units is only about half that of the ordinary feed pump, while compared to high grade pumping engines it is much less.

STEAM IN PUMP CYLINDER

Question:— In a duplex pump feeding a boiler, is there steam in the cylinder at boiler pressure all the time? That is, does the steam remain at full pressure even after the stroke is finished until the other side has almost finished its stroke?

Answer:— The articles on "Overhauling and Adjusting In the Engine Room" contain information on this subject. However, we will explain the matter here for the benefit of those who have not read the articles. The steam is opened on the right hand cylinder by the left hand plunger moving forward. As the left hand plunger moves forward it gradually opens the right hand valve to give steam until it is full open to steam and open to exhaust on the back of the piston. The left hand rod will reach the end of its stroke before the right hand rod, and as the left hand valve is operated by the right hand rod, boiler pressure will be maintained on the left hand piston until the right hand piston has travelled past half stroke, when the left hand valve will begin to move over to give steam at the back of the left hand piston to make the return stroke, and the front end will be open to exhaust. There will thus be a slight pause between the rod reaching the end of the stroke and its start on the return stroke, during which time the full boiler pressure will be maintained. If the pump is working slowly this can be plainly seen, but of course is not so noticeable when the pump is working fast.

A STOKER QUERY

Question:— Will some of the many readers of Power House tell me the cause of stoker rods in Jones underfeed stokers burning off. We have a battery of four boilers equipped with Jones stokers, and the rods burn off frequently. The forced draught comes in at the back end of the retort.

Answer:— This condition does not occur in the newer types of Jones stoker, but was occasionally found in the older types. The trouble is in the burning out of the back of the retort, allowing the hot coals and ash to reach the rod. This can be prevented by building up the back of the retort where the rod passes through with firebrick or high temperature cement, thus preventing the burning of the back plates and rod.

A COMBUSTION QUESTION

Question:— Will you explain fully why it is more economical to have quick combustion than medium? If a ton of coal burned in a furnace for ten hours, generating a steady temperature of 1400 degrees Fahrenheit, would it be equal to a ton of coal burned in five hours at a temperature of 2800 degrees? Which will burn to the best advantage and evaporate the most water to a ton of coal? Are there any cheap and reliable instruments for observing and recording combustion conditions?

Answer.— One ton of coal contains a definite amount of heat units, and can only give up that amount. The efficiency of the combustion will depend entirely on whether the correct amount of air is admitted to mix with the coal, and if this condition obtains the rate of combustion will not matter. However, in practice it is found that when combustion takes place rapidly, a better mixture of air and carbon takes place, with a resulting higher temperature, and increased efficiency. It must be remembered that in steam generation the object is to get a high temperature in the furnace to transmit the heat rapidly to the water in order to evaporate it. The temperature of the flue gases will depend on the amount of air admitted to the furnace, and the efficiency of the heating surfaces of the boiler.You cannot take the difference of the furnace temperature and flue gas temperature, and call that the effective temperature. The efficiency will depend on whether the loss of heat between the furnace and the flue gases is caused by the boiler taking up heat from the gases or whether they have been cooled by air entering the setting between furnace and flue. You might have first class combustion conditions in the furnace, and through bad baffling or leaks in the setting have the gases either going straight out to the flue giving up very little heat, or on the other hand air leaking in the setting cooling the gases down and producing a low flue temperature. The advantage of a CO_2 instrument is beyond question, whether the boiler is on a heating system or otherwise. Consult advertisements for suitable instrument.

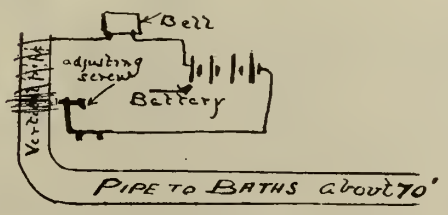
HEATING BUILDING

Question:— I have some trouble in heating the north and west rooms in a three story block, having a one pipe system, carrying seven pounds per sq. inch in cold weather. The main steam pipe comes from the boiler to the S. E. corner of the basement, and is reduced to 3 inches by a T, one branch leading across the south side of the building, and the other running along the east side to the north, where it crosses over to the west and back along the west side to the south again. Thus there is a three inch pipe supplying the south side of the building, and a three inch pipe supplying the other three sides. The drips are all collected at the southwest corner of the block, and returned to the boiler. What should be done to remedy this trouble?

Answer.— You have a five- inch pipe, which has an area neglecting fractions of 25 square inches. From this are taken two three inch pipes the combined area of which is only 18 square inches. Thus you have only 18 square inches to carry the supply coming from 25 square inches The pipe leading from the T to the north and west side of the building should be four inches instead of three which would give it an area of 16 square inches against nine square inches for the south side. This is nearly double, and would make an improvement. It would be cheaper to do as you suggest and put in a two inch pipe on the south side, but you would be reducing the capacity of the whole building. It is better to have free and unrestricted pipes, and if the larger main is used for the larger portion of the building, there will be better results. You would not need to carry the large main right around the building, but reduce it as the number of radiators or coils get less. For instance you might have it four inches long the east side, three inches along the north and two inches along the west. This of course is only approximate, and should be regulated by the amount of heating surface to be supplied.

CURING A HOT WATER TROUBLE

We had a great deal of trouble in the plant I am in, with the hot water system. The hot water is used for laundry and bathing purposes, and it was sometimes beyond the capacity of the system to supply the sudden demand. There was therefore an installation of two tanks, one of which was supposed to act as a storage for hot water, while the other was connected to the heater, and as the supply would go down in the storage the water in the tank connected to the heater would be warming up ready to change over. However as there was no way of telling when this reserve supply had been drawn off we often got caught by a sudden demand with the reserve tank cold. I noticed that the long supply pipe going from the tanks to the bath would contract about half an inch of its length when the water got cold, and from this fact I was able to rig up an alarm that would always give us warning when the water was getting cold. I connected up a battery and bell as follows. From the battery to one terminal of the bell, and from the other terminal of the bell to the water pipe taking a few turns



round the pipe with wire. From the other connection of the battery a wire was taken to a piece of flexible angle metal, and a screw was fitted in this to make the gap adjustable. When the pipe contracted due to cold water a connection was made with the angle, and the bell would ring. Very simple, but did the trick, and has never failed to work since it was installed.

WASHING DOWN BOILERS

I was interested in reading Mr. McLaren's article on the subject of blowing down boilers, and agree with him when he says that the proper time to blow down boilers is when the fires are active. I have had this proven to my satisfaction by observing the boiler emptying with fires out and no pressure on, at which time I have noticed that as the water leaves the tubes it does not remove the mud and sediment resting on them I have also noticed that the water leaving the blow-down was practically clean until the water reached nearly the bottom of the boiler.

I was told by an old engineer that the best way to empty the boiler is to wash it down as the water goes down in the boiler. thus removing the mud and sediment that is lodged on the tubes, and preventing it getting hard, especially when the boiler is still hot. I have tried this and found it work very satisfactorily. I also use a handy tool for scraping the scale off the tubes. It is made of three eighth inch dia. iron rod, one end being bent into a ring for the hand and the other bent to the radius of the tube. This can be pulled along the top of the tube scraping the scale off, and by reversing can be used to scrape the scale from the lower part of the tube.— G. D. B.

HORSE POWER FOR MOTORS

Question

What power would be required at the engine to drive a small manufacturing plant, having the following motors installed, and requiring 50 H.P. for the lighting load?

3 motors 16 H.P. efficiency of....82%
1 motor 20 H.P. efficiency of....85
2 motors 30 H.P. efficiency of 88
1 motor 9 H.P. efficiency of....80
1 motor 3 H.P. efficiency of....72

Please give horse power required if engine is direct connected, or belt connection is used.

Answer:

			Efficiency of Motor
3 motors	16	H.P.	.....82% = 55 H.P.
1 motor	20	H.P.	.....85% = 23.5
2 motors	30	H.P.	.....88% = 68.2
1 motor	9	H.P.	.....80% = 11.2
1 motor	3	H.P.	.....72% = 4.2
Lighting			50

215.6 H. P.

required to be delivered at the end of the cables supplying motors assuming the loss in conductors as 3 per cent, we get

215.6

$$\frac{}{.97} = 223.3 \text{ H. P.}$$

required at terminals of dynamo assuming efficiency of dynamo to be 93 per cent, we get

$$\frac{223.3}{.93} = 240.1 \text{ H. P.}$$

required at dynamo shaft.

If direct coupled, say efficiency of engine = 90 per cent, then

$$\frac{240.1}{90} = 266.8$$

If belt driven, say efficiency of engine and belt equal 85 per cent, then

$$\frac{240.1}{85} = 282.5 \text{ H. P.}$$

Direct driven, say 270 H.P. in engine cylinder; belt driven, 285 H.P. in engine cylinder

Useful work = 140 in motors + 50 in lamps= 190.

$$\frac{190}{270} = 70 \text{ per cent for direct driven.}$$

$$\frac{190}{285} = 66 \text{ per cent for belt driven}$$

ERRATA

An unfortunate error occurred in the issue of July 5th in the advertisement of the Diamond Specialty Co. The firm name appeared as the "Diamond Power Specialty Co.," whereas the word "Power" should have been omitted.

TORONTO NO. 1 LODGE C.A.S.E.

Toronto No. 1 Lodge C. A. S. E. is holding a picnic on July 30th on the Exhibition Grounds, Toronto, and a big day is looked forward to. The ground chosen is very suitable and convenient for a picnic, and the go-ahead members of this live lodge may be depended upon to make it a hummer.

LONDON LODGE C.A.S.E.

London Lodge C.A.S.E. held a very enjoyable picnic at Springbank on July 9, when a number of sporting events were run off. We had not the pleasure of being there, but the name of George Moll on the programme as chairman of committee assures us that there was nothing left undone to make it a success. There were in all 16 events, including some for all present, babies, boys and girls, married ladies, single ladies, benedicts and bachelors, and we believe all concerned had a great time.

SAVING WORN MACHINERY BY NICKEL

The high cost of iron and steel has stimulated engineers to develop efficient means of restoring parts which have become so worn that they are fit only for the scrap heap. A typical example is an engine crank shaft, which after a certain degree of wear, gets out of line to such an extent that it is useless. Welding has been largely used in the work of restoration, fresh iron or steel being welded on to the worn parts, and the whole then made true in a lathe. There are objections to this process in certain cases, and in order to overcome these objections a British engineer has developed a method of depositing nickel on the worn parts. The piece of machinery to be treated is first made free from grease and dipped bodily into a bath of molten wax. After the wax has cooled it is removed from the parts which have to be restored and is left on the others as a protective covering. Cleaning in a bath of acid is followed by immersion in an electro-plating bath which deposits nickel on the exposed surfaces. The coating of nickel is extremely hard, and when the process is properly carried out the nickel adheres with remarkable tenacity to the metal on which it has been deposited. Crank shafts, spindles, axles, pistons and similar objects can be made quite serviceable again by the nickel layer at a cost below that of replacing the whole part. Deposits up to one-eighth of an inch can be applied successfully. It is expected that this process will be developed alongside the welding process which British engineers have brought to so high a pitch of usefulness in many repairs, such as the mending of cracked or broken castings, which could not be handled by the deposition of nickel.

X-RAYS FOR FITTING BOOTS

Judging by the number of people who suffer from corns, bunions, flat feet and kindred troubles, the art of fitting boots is largely in need of scientific assistance. This assistance is now being given in Great Britain by means of X-rays. A simple, self-contained X-ray apparatus has been produced by which the customer and the shop assistant can see, on a fluorescent screen, the bones of the foot. The picture thus given shows exactly the real structure of the foot, from which an intelligent shop man can gauge the type of shoe which will give the customer the support and comfort he, or she, desires. The electric power required is so small and the exposure of such brief duration that there is absolutely no fear of any burning or ill effects from the use of this appliance.

A HARBOUR CUT OUT OF SOLID ROCK

There is a natural impression that all constructional engineering work of the ordinary kind in Great Britain was suspended during the war, but in point of fact it was found possible to keep quite a number of schemes going in spite of the concentration of effort upon definite war work. A case in point is supplied by an extensive harbour improvement which was begun in Great Britain a month or two before the war. The scheme included a new basin with an area of 2¼ acres and 1500 feet of new quays. All through the war the work proceeded steadily, if slowly. Its most remarkable feature was that the basin was cut out of solid rock to give an average depth of 13 feet. The material excavated was ingeniously used to reclaim from the sea a considerable tract close to the harbour.

"CARRYING ON" IN SPITE OF NO COAL

It is universally recognised that British engineers display their highest qualities in most serious emergencies, and this fact was amply proved during the recent prolonged coal stoppage. The electricity supply stations kept going by means of rapidly installed oil burners, and the gas works maintained an uninterrupted supply for a far longer period than was thought possible, by means of utilising their stores of coke in the production of water gas. Another interesting development of a more homely character was the institution, in Birmingham, of central supplies of hot water. These supplies were instituted for the benefit of the poor, who needed all their exiguous provision of coal for cooking purposes.

Speaking on acetylene gas as a lighting medium, the Daily Telegraph, Sheffield, England, states as follows: For country houses, the acetylene gas plant is simpler and more easily worked than the usual dynamo and accumulator; a layer of coke was put into each half core mainly to save good core sand and to keep the cores as light as possible, a little time in drying being also saved on this account.

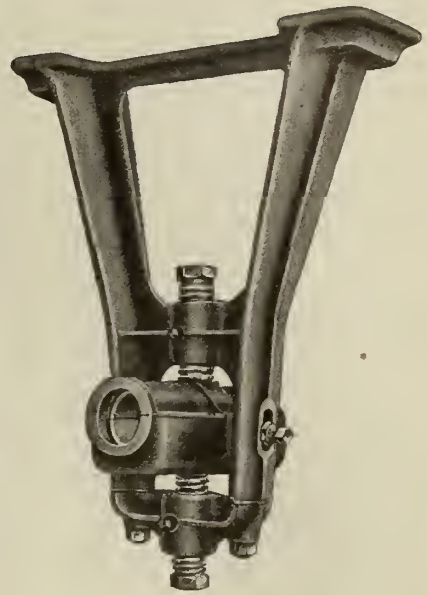
No special analysis was called for, the regular ten per cent. charge of semi-steel approximately 2.15 silicon, as used in the mixed class of work turned out by this company, serving the purpose admirably.

Owing to the fact that the company decided to grind the flange faces instead of machining, careful core jointing was necessary, three thirty seconds stock only being added to each flange face as finishing allowance.

The Philip Gies Foundry, Kitchener, have gone into the manufacture of specialities, among them being the Superior shaking and dumping grate bars. These can be adapted to any style of boiler.

The University of Illinois Engineering Experiment Station have issued Bulletin No. 120, which is the third in a series on warm air furnace research. This research into warm air furnaces and heating systems is being conducted in cooperation with the National Warm-Air Heating and Ventilating Association. This research should have far reaching effects both from a coal economy standpoint and a comfort standpoint, for there is no doubt that the average heating arrangements in houses on this Continent leave much to be desired from both these angles.

For Your Transmission



Oneida Steel Split Pulleys are both strong and light in weight. The smooth, grooveless, oval crown provides an ideal surface for belt contact. Oneida Pulleys will transmit power under low belt tension which means less power loss.

Universal Giant Hangers are standard equipment. Regular weight and perfect castings fitted with large plunger screws ensure perfect alignment. These hangers have universal adjustment and can be fitted with either Ring Oiling or Hyatt Roller Bearings.

Fairbanks Wood Split Pulleys embody many excellent features. All material is passed through two kiln drying processes. The web, which is mortised into the arms and rim, holds the whole pulley securely together.

Our nearest Sales Office will gladly furnish any information you may need.

If it isn't here write us.

Pillow Blocks,
Post Boxes,
Cast Iron Pulleys,
Cold Rolled Shafting,
Dick's Balata Belting,
Graton & Knight Leather Belting,
Clipper Belt Lacing,
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THE CANADIAN FAIRBANKS-MORSE CO., LIMITED

Canada's Departmental House for Mechanical Goods

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Fairbanks-Morse

LOCOMOTIVE BOILER MUD HOLES.

By H. BAILES.

Anyone familiar with the present method of gauging these mud holes with a plate knows that this system is inaccurate. First of all, dirt and rust adhere to the threads, and secondly, the plate only measures the bottom of thread on plug. In the rush of making a speed "test out," quite frequently the taps are not put in these holes to clean out or straighten up the threads, with the result that many plugs are blowing steam when the engine ought to be leaving the shops.

After tapping all the holes in a boiler, the writer has used with good success a set of old plugs for the purpose of gauging the size of these holes. The plugs are from 1⅞″ diameter to 2½″ diameter, these increasing by 1-16″, this making eleven plugs to the set. The size of the plug is determined by calipering the fourth thread from the end, i.e. ⅜″ from the end, or the width of a pair of outside thread calipers.

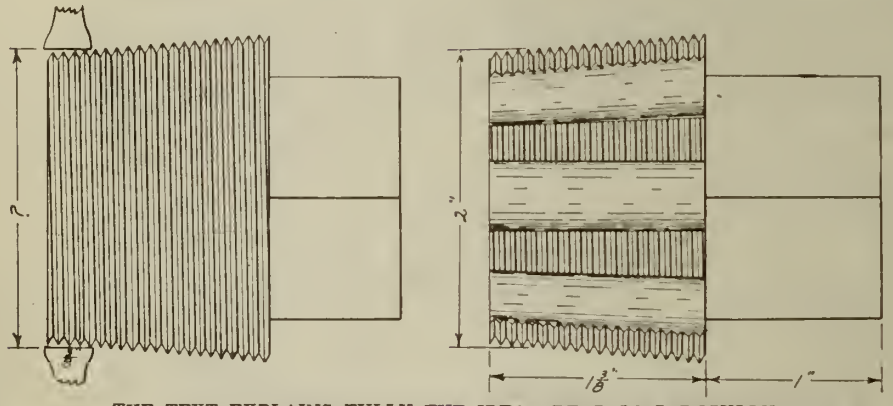
Each plug is stamped on top as follows: 1-7, 1-15, 0, 1, 2, 3, 4, 5, 6, 7, 8; 0=2″ diameter, and the whole numbers above this signify 1-16″ increase in diameter. No. 3 represents 2 3-16″ diameter; No. 4, 2¼″ diameter, and so on. Below the cipher No. 1-7=1⅞″ diameter; 1-15 1 15-16″ diameter. In use, the practice is to chalk above each hole the number of the plug used. Thus, the abbreviated method of marking comes in very handy.

In some cases a plug may enter three or four threads only. For example, suppose this happened with a number four, or 2¼″ diameter plug. A No. 3 plug would enter this same hole to within four or five threads of the top. What would be the size to take? In such an instance, the mean diameter or 2 7-32″ would be correct, the hole to be marked 34, signifying the diameter as being the mean of these two sizes. Thus, 56 would equal 2 11-32″; 1-31 = 1 31-32″, etc. From past experience, I found these sizes comprise the standards excepting inspection holes and one or two isolated cases, viz.: 1⅝″, 1¾″, and 1 13-16″ diameter, which may be determined by inside thread calipers.

Now, substitute taps for the plugs, i.e., plugs duplicated in hardened steel, and milled with teeth for cutting purposes. The mud holes of many boilers vary from three to four sizes, so it is merely a question of measuring one hole with your scale and securing one or two plug taps above or below the size measured. By this method you are sure to use the taps, and besides, these taps are more effective, to my mind, in tapping new holes than the usual long standard tap.

The method of using old plugs is also expensive and inaccurate, the process being to anneal them before sending to the lathe. The lathe hand has plate sizes for one set and proceeds to chase the threads up with a hand chaser. In many cases the plugs are returned with a taper which does not correspond to the hole. In conclusion, I would suggest a set of adjustable dies, graduated similar to the plug taps, of the same taper and pitch, so that the old annealed plugs could be rethreaded by unskilled labor, using an old drill head.

Hollow concrete piles are being made by a novel process in Los Angeles, according to the Engineering News Record. They range from 42 feet to 60 feet long by 18 inches to 20 inches outside diameter, with a thickness of about 4 inches. A solid point of reinforced concrete is made and stood on end in a high scaffold. Paper cylinders representing the internal diameter of the pile are then erected above the point and the reinforcement put in place. Cement-granite concrete is then applied by means of a cement gun, in stages of about 6 feet high. After standing from eleven to fifteen days the piles are picked up by a locomotive crane and leaned against a rack to season for thirty days. They are then transferred, still in the vertical position, to a rack on a barge for conveyance to the works. By these means it is hoped to avoid the cracking sometimes caused by upending piles cast horizontally.



THE TEXT EXPLAINS FULLY THE IDEA. READ IT CAREFULLY.

NEW TYPE INDICATING PRESSURE GAUGE

The "Gasmaker's" gauge, a recent development of the Schaeffer & Budenberg Mfg. Co., of Brooklyn, N.Y., fills a long felt want of the gas industry. The tendency to increased production in gas plants puts bigger loads and consequently higher pressures on every piece of gas works apparatus. It is very difficult to successfully use water gauges in the measurement of pressures much over 36 in. and this has led to the development of this new type gauge. Furthermore, glass column gauges are extremely fragile and hard to read.

The gauge shown is very substantially constructed and will stand any kind of abuse. Continuously fluctuating pressures such as produced on a generating set or at the outlet of an exhauster have absolutely no detrimental effect upon it. The gauge is of simple construction with few moving parts and practically nothing to get out of order. The movement of a diaphragm of metal, specially selected so as to withstand the action of any gas (even chlorine gas) is transmitted to a pointer on a dial, which is calibrated in "inches head of water," for any desired range.

The gauges are adaptable to any service, such as on blast mains, generators, carburettors, superheaters, washboxes, condensers, tar extractors, purifiers, meters, or holder mains. In fact, wherever one desires to read pressures in inches head of water. They are also made for high or low pressure alarm service. An adjustable electrical contact point is placed on the dial and can be set to ring an alarm at any desired pressure. Should the pointer on the dial after long continuous service not return exactly to the zero position, an adjusting screw is provided for resetting. In fact, it is a universal gauge that can be constructed for use on any desired pressure or service.

Men in the manufacturing department of any gas company will immediately recognize the value of a gauge of this type.

DIESEL ENGINE PROGRESS.

Some time ago we described in these columns the Cammell Laird Fullager Diesel engine, which is of the opposed piston two-cycle type, and is also notable for the fact that the pistons in adjacent cylinders are connected by diagonal rods. The top piston of one cylinder is thus connected to the bottom piston of the adjoining one, and two cylinders and four pistons form a unit.

There is now being built a Cammell Laird Fullagar engine of 4000 B.H.P., which will be the largest unit yet built for marine work on the Diesel principle. This is a four-cylinder unit, and owing to the long stroke possible with this type of engine, the revolutions will only be 90 per minute, with a comparatively small cylinder diameter of 26 inches. The stroke of each piston is 42 inches. The comparison in weight and floor space is very much in favor of the two-cycle engine of the opposed piston type as against the four-cycle type of Diesel.

Trials recently made on the first 1000 B.H.P. unit built of this type gave a consumption per b.h.p. of only .39 lbs. fuel per hour.

SOMETHING NEW IN WINDMILLS

Many attempts have been made to solve the problem of efficiently utilizing the winds as a means of generating electricity. The difficulties arise from the extreme variations in the force of the wind and from the liability,even in windy regions, to periods of calm during which no power at all can be obtained. The conditions suggest that wind power should be used only as an auxiliary to some other source of energy, such as the burning of coal or oil. Now that fuel of all sorts has multiplied in price there is all the more reason for considering the possibility of turning the wind to account. Hitherto the usual plan has been to use a large slow-speed windmill to drive a dynamo at a high speed through gearing—a rather wasteful arrangement. During the war, however, there was in Great Britain a remarkable development in the design and construction of small high-speed dynamos on aeroplanes. These dynamos were direct-coupled to propellers or rather "impellers" driven by the wind created by the aeroplane in flight. A British firm has devised a scheme for fitting three or more of these wind-dynamos on the swivelling top of a vertical pole; with a vane to keep them in position against the wind. Each equipment gives 60 watts, and the arrangement forms a cheap and efficient auxiliary to the ordinary country-house lighting installation. The energy produced is, of course, stored in accumulators in the usual way. The operation of the plant is entirely automatic and it is so light and simple that it presents no obstacles in erection and maintenance.

A RAPID STONE-CUTTER

Machines for cutting marble and other stone have a pedigree stretching back to very early days in civilization and they still often bear the marks of their primitive ancestry. Recently, however, a British engineering firm introduced a type which more closely resembles a machine tool than the crude equipments with which our forefathers were content. It is intended mainly for cutting and moulding but it may be used also for slab and block work. The stone to be cut is placed on a table surmounted by a saddle carrying a carborundum wheel or a "diamond saw", which runs at 1,200 revolutions per minute and is kept cool by streams of water. A diamond saw is built up by arranging individual diamonds in metal "saddles" on the rim of a disc. Each saddle is drilled from behind, the diamond inserted in the hole and electrically welded over, and then mounted on the rim. The metal covering the diamond is ground away leaving the diamond exposed. Wheels of this type make very rapid and efficient cutters of stone and the use of the machine is expected to lead to remarkable economies over the older methods.

STETHOSCOPE IN WORKSHOPS

Most of us are, unfortunately, more or less familiar with the stethoscope, which the doctor uses when listening for the signs of defective action in our lungs or heart. It is not so widely known that the same kind of instrument can be employed to detect abnormal noises in moving machinery. The latest development in this workshop stethoscope, due to a British engineer, lies in the use of a kind of telephone receiver in place of the stethoscope rod. The advantage of this device is that every bearing and every gear in a factory can be fitted permanently with a receiver and all the receivers can be connected by electric wires to a single board in the manager's office or any other convenient spot. By means of suitable switches the manager can examine each bearing or gear in succession without moving from the board. Since abnormal internal noise is often the first sign of trouble which may lead to breakdown, this simple and rapid means of detection is an invaluable aid to the factory owner.

The Refinite Company of Canada has been incorporated into premises at 319 Continental Life Building, Toronto, and will manufacture the Booth Water Softening Systems and the Refinite Pressure Filters. "Refinite" is a natural water softening mineral, and the company controls the only known deposits on this continent, it is claimed. The Company will be under the management of Mr. E. G. Koyl, who is an experienced water engineer. Mr. Koyl is a veteran of the great war, having enlisted in the first McGill University Company at Saskatoon, in 1915. The company will be represented at Saskatoon and on the coast.

The Underfeed Stoker Co. are now making a simple coal crushing device which can be attached to an ordinary standard stoker. The crusher has been invented and developed by two users of of the Jones stoker, and has been in use for over a year with good results.This crusher is placed directly over the hopper of the stoker, and the rolls are operated through a ratchet and lever connected to the pushrod of the stoker. The crusher is arranged to be operated by the return stroke of the push rod, thus utilizing the excess of power which is available on this stroke. The coal is thus crushed just as it is used, and the power used by the ram on each stroke is equalized. The feature of the crusher which will appeal to every power plant operator, is its simplicity, the whole thing being self-contained.

--and who wants to waste steam at present prices of coal?

With coal costing as high as $13 a ton—and often hard to get at any price—it is far cheaper to put in enough Steam Traps Sarco to stop loss of steam through condensation than to stand the alternative of big waste at the coal pile.

Steam Trap Sarco puts the whole question of proper trapping vs. waste of coal on an entirely new basis—

It pays for itself at points where a Big Trap wouldn't Be Justified.

You can put in three Sarcos for the cost of just one bucket or floor trap—thus for the same expenditure saving three times as much steam and therefore three times as much coal. Because it costs only one-third as much, a Sarco will quickly pay for itself at points where the expense of an old-style trap wouldn't be justified.

Sarco is more dependable and efficient than old-style traps. It operates automatically—on a simple yet extremely sensitive and responsive system of liquid expansion and contraction. So positive in action that not an ounce of live steam can escape from one year's end to the other.

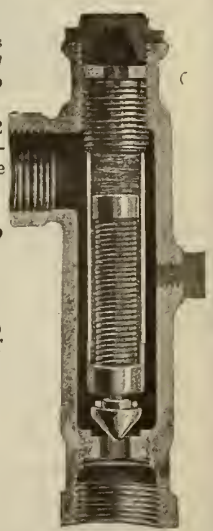
Drains off all condensate as fast as it forms—and immediately returns it to the hot well—while still hot, thus requiring less coal to convert it back into steam. And never any water (condensate) left in the pipes to freeze overnight or over Sunday.

30 DAYS' TRIAL.

We are ready to let Sarco demonstrate its superiority and economy right in your own plant by sending you one on 30 days' free trial without a cent in advance. If for any reason you aren't satisfied with its performance, you can return it and it won't cost you a cent.

Made in sizes ⅜ in. to 3 in. for any given pressure up to 200 pounds.

Booklet No. J-12 and full particulars about our free trial on request.



SARGO CO., INC.
230 Broadway.
NEW YORK
BUFFALO CHICAGO
CLEVELAND DETROIT
PHILADELPHIA

Steam Trap Sarco

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

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Penberthy Injector Co., Windsor, Ont.

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Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
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Can. H. W. Johns-Manville Co., Toronto.

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AUTOMATIC ICE RECORDING DOORS AND CHUTES
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BELTING, BALATA
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BELTING, CONVEYOR
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Gutta Percha & Rubber Co., Limited.
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Mueller Mfg. Co., Ltd., The.

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Mackinnon Steel Co., Ltd., Sherbrooke, Q.
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Sexton Boiler Setting Co., W. R., Toronto.

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Sturtevant Co., B. F., Toronto, Can.

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BOILER BAFFLE WALLS
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Shell Bar Boico Supply, Ltd., Toronto.
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Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
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Penberthy Injector Co., Windsor, Ont.
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By installing Evans' "ALMETL" Firedoors in your plant, you entirely eliminate the danger of fire spreading. They afford the best protection that money can buy or brains devise.

"ALMETL" Firedoors are built of steel, heavily galvanized—there are no wood cores "protected" by light terne or similar covering. The "ALMETL" is absolutely guaranteed not to sag, twist or warp, and will withstand the most intense fire. There's not a bolt used in its construction—all joints are RIVETED. The interlining of asbestos rollboard is a special feature.

Our Department "A" will gladly furnish drawings and details of the "ALMETL."

Geo. W. Reed & Co., Limited

MONTREAL

MADE IN CANADA

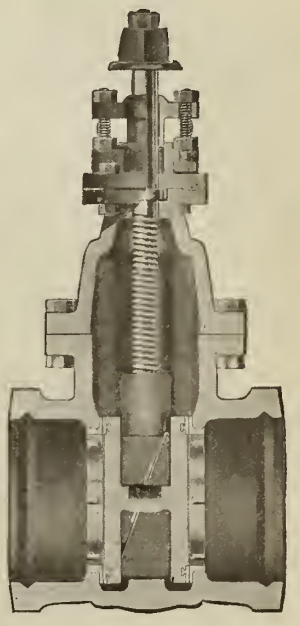
DARLING PATENTED FIRE HYDRANT

Flanged connection to hydrant base permits pointing the nozzle in any direction. Bottom of base comes on level with water main and does not require excavation below main.

DARLING PATENTED GATE VALVE

The large valves that are operated in a horizontal position require no auxiliary mechanism for carrying the internal parts. The discs themselves roll like two wheels and carry the wedges.

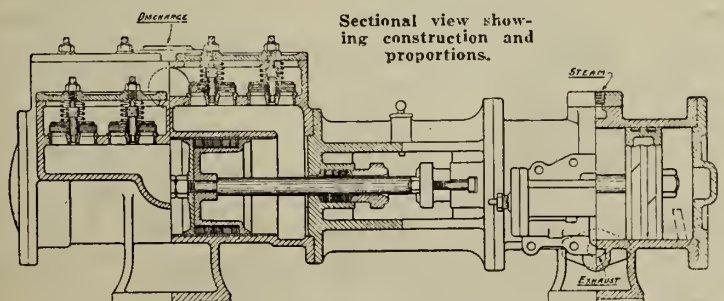
MADE IN CANADA



DOMINION STEEL PRODUCTS CO., LIMITED

DEPARTMENT O. - BRANTFORD, CANADA

HEPBURN PATENT VACUUM PUMP



Sectional view showing construction and proportions.

A High Pressure Packed Piston Pump for long and continuous service.

Look at its "Works"

The Inside of a Hepburn Patent Pump tells the whole story. Note the position of the Steam chest on the side of the cylinder. The low ports make the steam Cylinders self-draining—a feature belonging to no other Canadian-Made Pump. The valves are readily accessible; there are no screw threads on Valve Seats or Valve Stops and the entire pump is a marvel of simplicity and a paragon of efficiency.

Complete information on request.

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LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER BELTING
W. J. Brown (Tucks), Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd. Montreal.
B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

METERS
Dominion Flow Meter Co., Toronto.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

Godfrey Conveyor Co.

127-147 Thirteenth Street, ELKHART, Ind., U.S.A.

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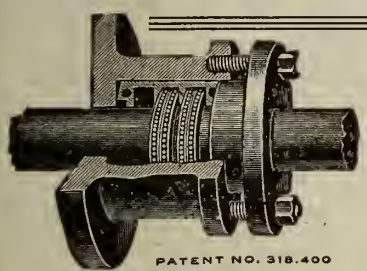
operating Gravity - Filled Bottom Dump Bucket by Monorail or Cableway.

Canadian Office:

M. A. KENNEDY, LIMITED

TORONTO, CANADA

106-110 Richmond St. West Phone Adelaide 7511



PATENT NO. 318,400

PAT. NO. 500,899
" " 534,104
" " 802,328
" " 854,541
" " 654,542
" " 725,388
" " 774,490
" " 775,193
" " 775,194
" " 791,300
" " 805,689

PAT. NO. 829,116
" " 830,530
" " 856,103
" " 876,238
" " 894,537
" " 895,791
" " 893,068
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" " 934,829
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HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

PLIBRICO can be molded to fit any place in the furnace or setting.

Ask for our book L-34 on Furnace Building

PLIBRICO JOINTLESS

FURNACE LINING

After being molded into shape and properly baked and vitrified PLIBRICO makes front-door arches, side walls, bridge walls, and baffles that are air tight and gas tight. No leaks to retard combustion and thus eat into the coal pile—and the pocketbook. Any man can apply it. No forms needed. Excellent also for patching.

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

JOINTLESS FIRE BRICK CO.

1142 CLAY ST., CHICAGO, ILL.

DISTRIBUTORS:—Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans, Coleman & Evans, Vancouver, B.C., Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman, Clancey & Grindley, Calgary, Alta.

How to Test Advertising

THE man who doubts the power of advertising belongs in the same class with the man who refuses to believe that the world is round simply because he can't get off somewhere at a distance and see its roundness for himself.

The merchant who fears to attempt advertising because he figures it as an "expense" is blind to his own interests. I personally know several men who, because they once tried advertising to the extent of a cheaply printed hand-bill and didn't find it necessary next morning to call on the police to keep the crowds of eager buyers from swamping their store, loudly and solemnly aver that "advertising doesn't pay."

Advertising *does* pay.

The most successful merchants are the merchants who believe most thoroughly in advertising and who practice their belief.

But advertising, in order to pay, has got to be *intelligent* advertising.

The day of hashed-over superlatives — "best goods," "lowest prices," "best stock in town," "greatest bargains ever heard of," and so on—has passed.

People have learned to distinguish the *truthful* advertiser from the blatant behind-the-times storekeeper who believes that, so long as *he* claims to have the best goods on earth, or under the earth, or within wireless distance of the earth, people will break their necks trying to get to his counters in the forefront of the crowd.

Put some *brains* into your advertising.

Don't let the office boy write your announcements in between his other duties.

Don't doubt the business-getting and business-building power of intelligent and informative publicity — and you will find that advertising *does* pay.

—*Jerome P. Fleishman.*

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Supply Co., Montreal.
W. J. Brown (Tucks), Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Bolco Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg Co. Toronto.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Darling Bros Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co. Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co. Limited. Toronto

RAGS
Shell Bar Bolco Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Can. H. W. Johns-Manville Co., Toronto.
Dominion Flow Meter Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDEDS CO2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budeuburg Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 23 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

HINTS TO BUYERS

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Trial Orders Solicited—Our Packings Do the Rest

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED

London Liverpool Cardiff, Etc.

Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.

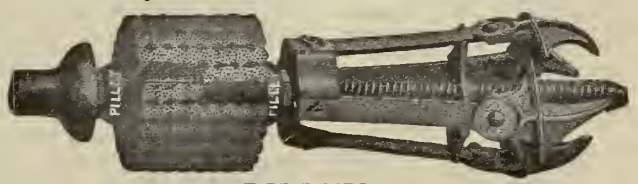
Stocks carried in all sizes TEL. No. MAIN 2387

PUMPS

The high-class made-in-Canada product which we are putting on the market will entirely justify you in keeping your dollars in this country.

The Smart-Turner
Machine Co., Limited
HAMILTON, CANADA

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
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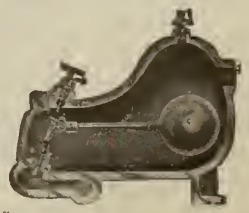

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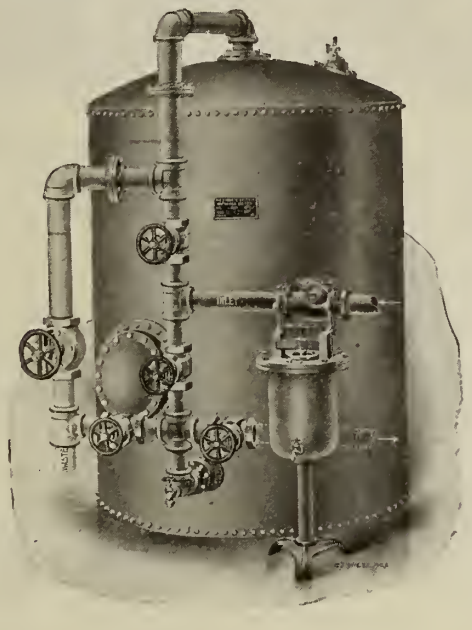

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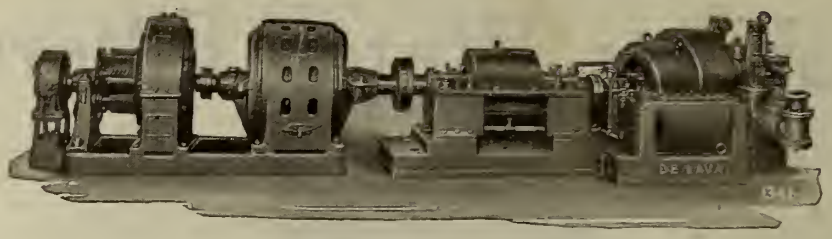

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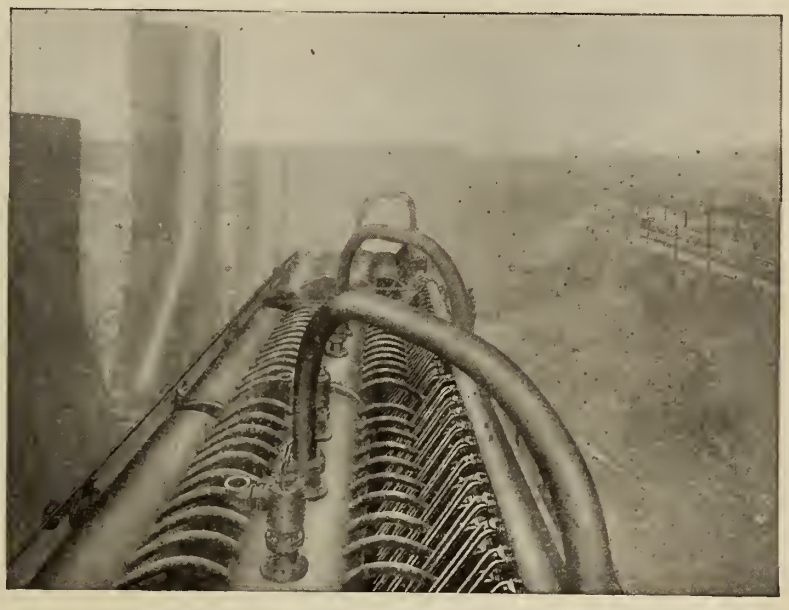

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Reducing Valve
Type 10

FISHER
TRADE MARK
REGISTERED

Order Fisher Specialties Through Your Own Jobber

Fisher Specialties can be quickly and easily ordered through your own jobber anywhere in Canada.

Type 1

Over forty years of successful operation under all conceivable conditions have given Fisher Steam Specialties an enviable record for accuracy, long-lasting satisfaction and low repair cost.

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Pressure Regulator
Series 90

is more than a reducing valve. It delivers exactly the proper amount of steam necessary to maintain the required heat in cooking kettles, rendering vats, vulcanizing tanks and all other classes of dead end service. It also shuts off absolutely all supply of steam when the process it is serving is suspended.

Series 90

Fisher Steam Trap
Type 33

will keep your steam lines absolutely free of all condensation. It insures your steam reaching its goal dry and hot. Valve is placed at the top of trap away from all possible dirt or other foreign impurities.

Intermittent discharge, eliminates wire-drawing and consequent steam leakage.

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Type 1

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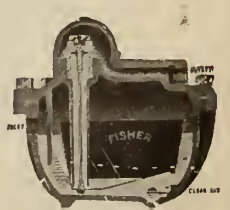

Type 33

These are just a few of the line of famous Fisher Specialties. We will be pleased to send you our complete catalog of Fisher Power Plant Specialties. It is an attractive book full of interesting information to Canadian engineers. Write for it today.

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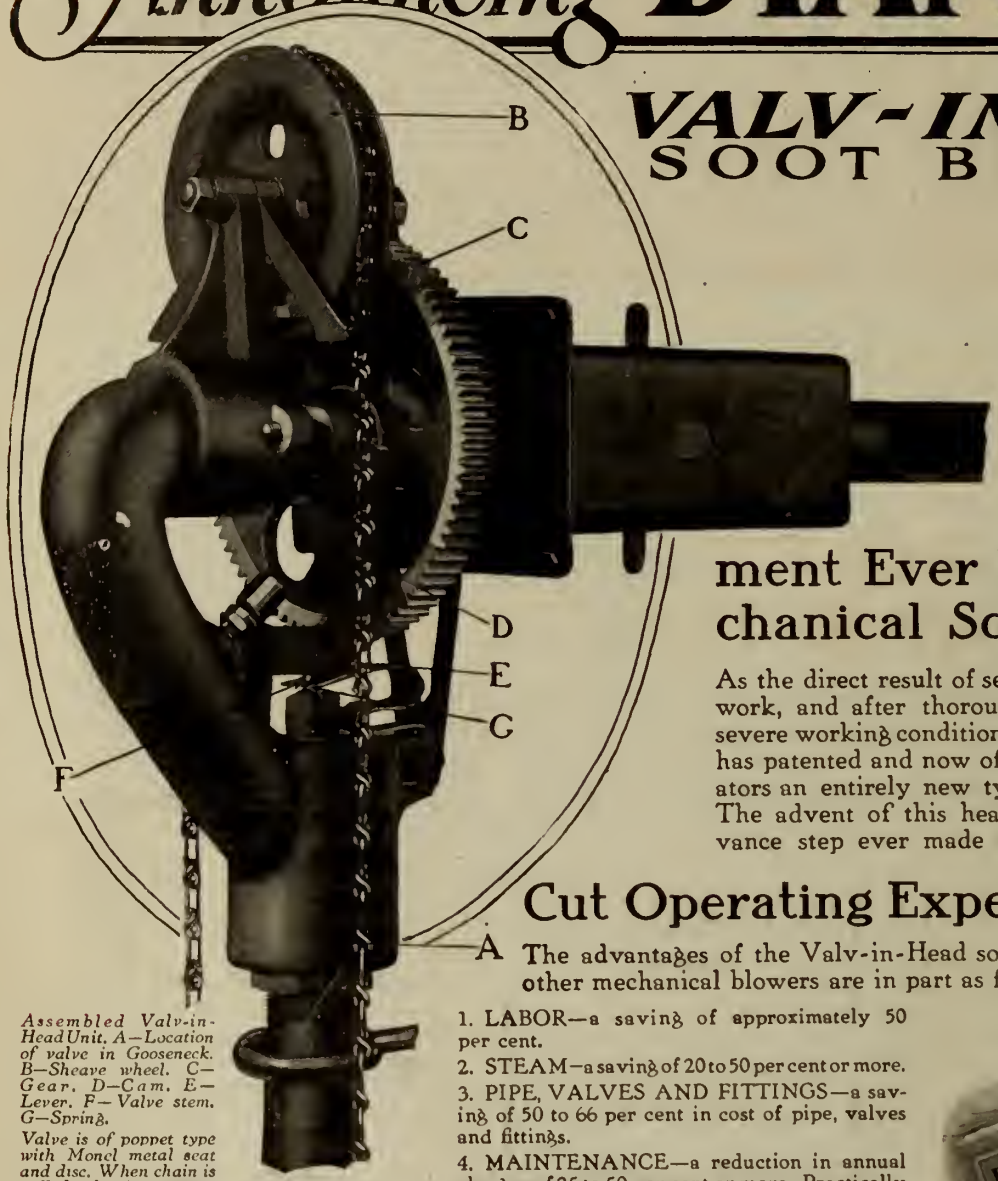
Announcing DIAMOND

VALV-IN-HEAD SOOT BLOWERS



Assembled Valv-in-Head Unit. A—Location of valve in Gooseneck. B—Sheave wheel. C—Gear. D—Cam. E—Lever. F—Valve stem. G—Spring.

Valve is of poppet type with Monel metal seat and disc. When chain is pulled valve is operated by Cam D and Lever E.

The Most Important Improvement Ever Made in Mechanical Soot Blowers

As the direct result of several years' experimental work, and after thorough tests under the most severe working conditions, the Diamond Company has patented and now offers to power plant operators an entirely new type of soot blower head. The advent of this head marks the greatest advance step ever made in the soot blower field.

Cut Operating Expenses in Half

The advantages of the Valv-in-Head soot blower as compared to other mechanical blowers are in part as follows:

1. LABOR—a saving of approximately 50 per cent.
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5. EFFICIENCY—greater cleanliness of boiler assured.
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7. VALVE DESIGN—time of opening and closing exactly adjusted to soot blower operating conditions, being slower than the standard quick-opening valve and faster than the standard globe valve, thus solving a problem of long standing.

Diamond Valv-in-Head Soot Blowers are described and illustrated in detail in our new Bulletin 287. Write for your copy.

Ask for Full Information

Valv-in-Head blowers are adapted to all types of water tube boilers.

On request our service Engineer will go over your existing soot blower installation and advise whether it can profitably be replaced with the Diamond Valv-in-Head System. Ask for full information.

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WINDSOR, ONT.

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Power & Heating Boilers

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Whether you are burning coal, screenings, refuse, wood, sawdust, gas or oil, we supply settings that burn it with the least labor and with best economy.

We build Heating Boilers up to 72" x 16', Return Tubular Boilers for power use, up to 165 H.-P.; settings, single or battery, in brick or all-steel.

BOILERS IN STOCK

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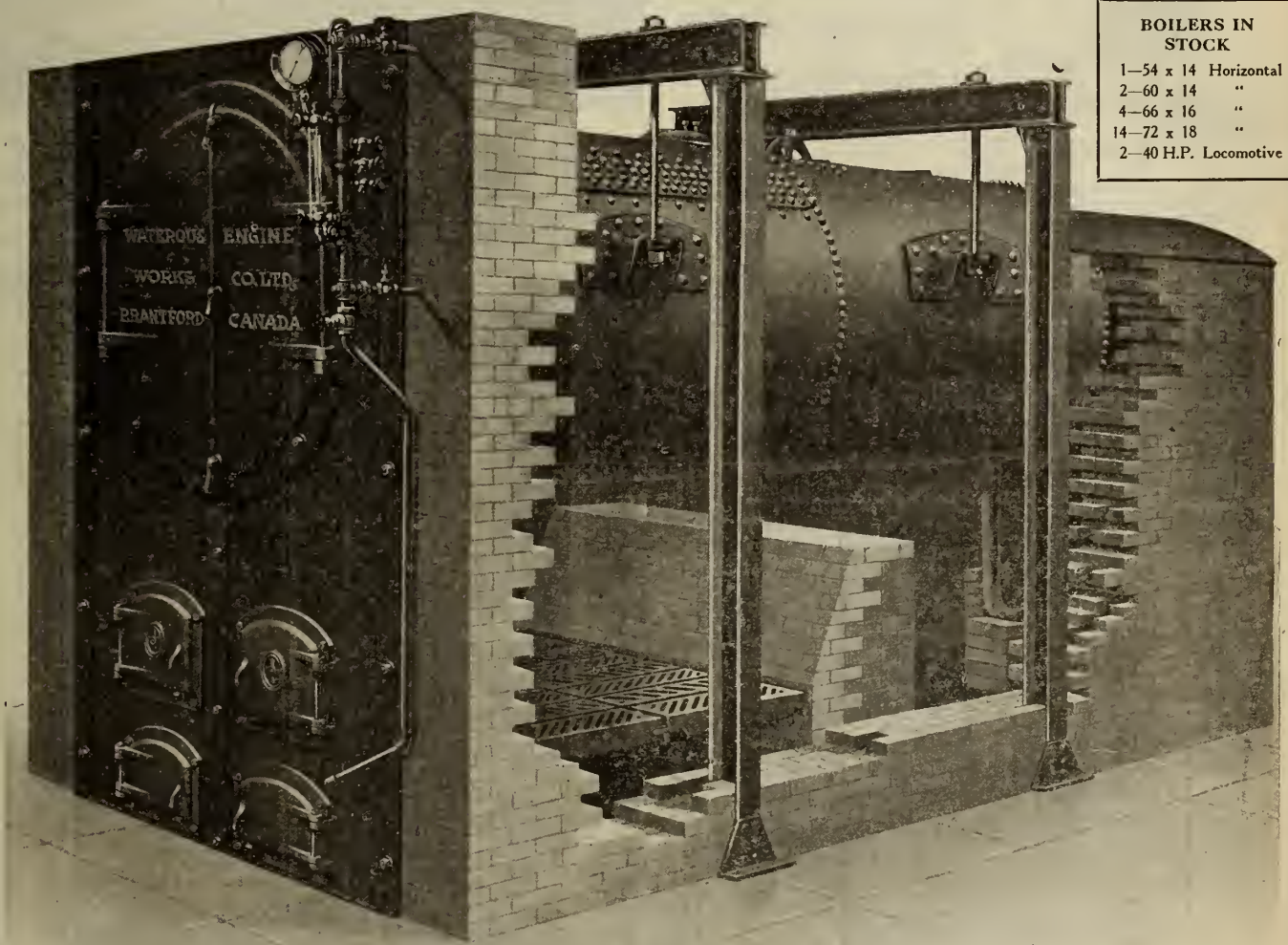
4—66 x 16	"
14—72 x 18	"
2—40 H.P.	Locomotive



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The Waterous Engine Works Co., Ltd., Brantford, Canada

Columbia Recording Thermometers now made with the New Time Punch!

With the addition of this ingenious little device to the Columbia Recording Thermometer you can now check up accurately on the operator who is responsible for maintaining a uniform temperature.

The Day-and-Night Chart gives you a true *record* of temperature variations—but the TIME PUNCH shows *whether or not the operator was watching the chart.*

The TIME PUNCH gives you absolute assurance, *for the first time,* that the man in charge of temperature control will inspect the chart at specified intervals. If he fails to push the button as instructed, you will know, by the absence of punch holes on the edge of the chart, that he has been delinquent. The operator who is indifferent, negligent or asleep at his post hasn't a chance against this small but highly efficient "silent sleuth."

Incompetency, too, is checked up by the TIME PUNCH. For if the chart indicates undue variations—and the punch holes show that the operator has noted them—*you know that he has not taken the proper steps to keep the temperature even.*

Columbia Recording Thermometers, Gauges and Tachometers are the only instruments fitted with this ingenious and highly valuable device.

Catalog H-33 gives full information about Columbia Recording Thermometers, as well as valuable information about increasing efficiency, reducing spoilage and cutting manufacturing costs. A copy sent free on request.

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Makers of Instruments for the Promotion of Efficiency in Power Plant and Manufacturing Departments.

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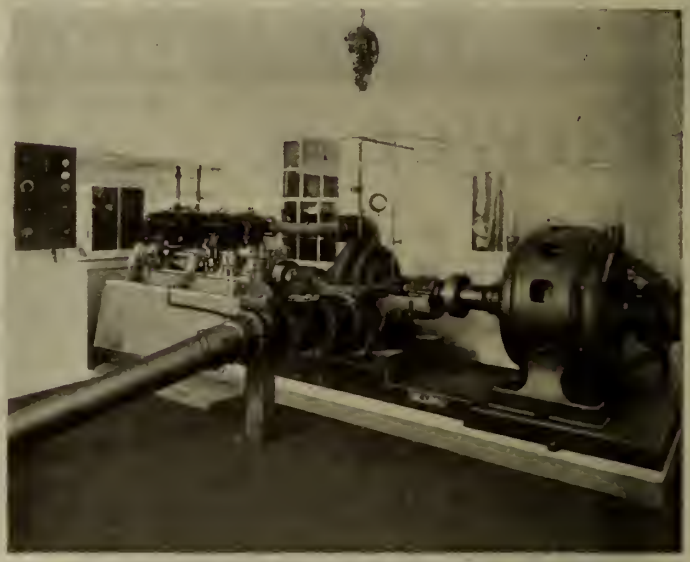
Consumes no Fuel **Sterling** THE ENGINE of REFINEMENT *For the finest boats that float* While standing by

Is your town paying a terrific cost for maintaining 40 lbs. of steam in a reserve plant for light and fire protection? Why?



Model FC-8 cylinder 185 H.P. STERLING direct connected to DeLaval 2 stage 8" centrifugal pump at Gorst Creek Pumping Station, Bremerton, Washington, as reserve Power. Capacity 1800 G. P. M., 285 ft. head, speed 1200 R.P.M.

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Gas and Gasolene Engines - - 12 to 300 H. P. speeds up to 1,750 R. P. M.

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Makes You Forget Your Furnace Troubles

After lining your boilers with PLIBRICO, forget them, for PLIBRICO means the end of worry.

It is a plastic material, easily installed, that when molded into baffles, bridge walls, side walls, and front-door arches makes a setting that is absolutely airtight and gas tight. Being jointless, there are no bricks to fall out or mortar to crumble.

After being baked and properly vitrified, PLIBRICO makes a furnace lining as solid as rock, and resistant to heat up to 3100 degrees F.

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Build permanent, properly flared, one-piece boiler arches and walls without any bricks to fall out.

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Junior Seatless Valve
For Exceptionally Difficult Service

Embodying the same excellent features which have gained wide and favorable recognition for the popular Yarway Seatless Blow-off Valve, this new YARWAY JUNIOR SEATLESS VALVE is especially designed to give unusual service on

Water Column Blow-Downs
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Soot Blowers
Turbine Drips
Superheater Drains
Steam Automobiles
Generators for Locomotive Headlights

and other difficult service where the ordinary seat or disc valve cannot be relied upon.

One of its most important advantages is the automatic regulation of pressure on the packing, controlled by the handwheel. After valve has closed, packing is tightened by turning hand-wheel. Before valve is opened pressure is first removed from packing. This Automatic protection results in unusually long life for the packing.

The YARWAY JUNIOR is made up in bronze, steel or iron, depending on the intended service.

Write today for celluloid sliding model, showing exactly how it works.

A few recent purchasers of Yarway Junior seatless valves:

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New Truths and Old Fallacies

Lubricating Quality—*Continued*

We try to keep Magnolia Metal at the peak of quality, and what we aim to furnish is quality and service, at a price much under that charged for Genuine or other high-grade babbitts, and at greater economy, however low the price of other grades may be.

Alleged Magnolia Metal formulas are published in every text book, as a part of its essential make-up, and is a distinction not accorded other similar proprietory brands. No two of these formulas are the same, unless copied, and in one instance, Doctor Dudley (deceased), then Chief of the Chemical and Test Department of the Pennsylvania Railroad, announced that Magnolia was composed of 83.55 lead and 16.45 antimony, with traces of certain impurities. Because of its authoritative source, this formula has been given wide publicity. As this was rather a good formula for competitors and copyists to follow, we have been content to let it go at that. Furthermore, as we have said before, we sell quality and service—not formula. Neither do we engage in a competitive scramble for business—we prefer to stay in our own class and hew to the line which we have always followed.

But we have not yet finished discussing the self-lubricating qualities of Magnolia Metal.

We always did realize the importance of this quality, and we knew that Magnolia possessed it, but the first high official confirmation of it was by the United States Government, in a most elaborate test made by three engineer officers at the New York (Brooklyn) Navy Yard.

(Continued next month).

For copy of complete article :

"New Truths and Old Fallacies"

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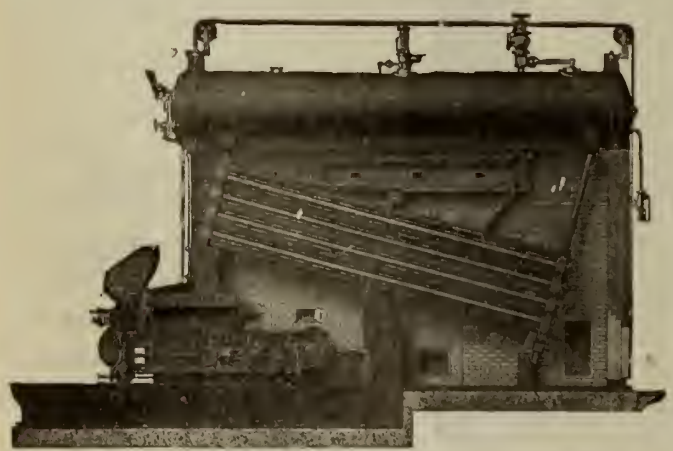
HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
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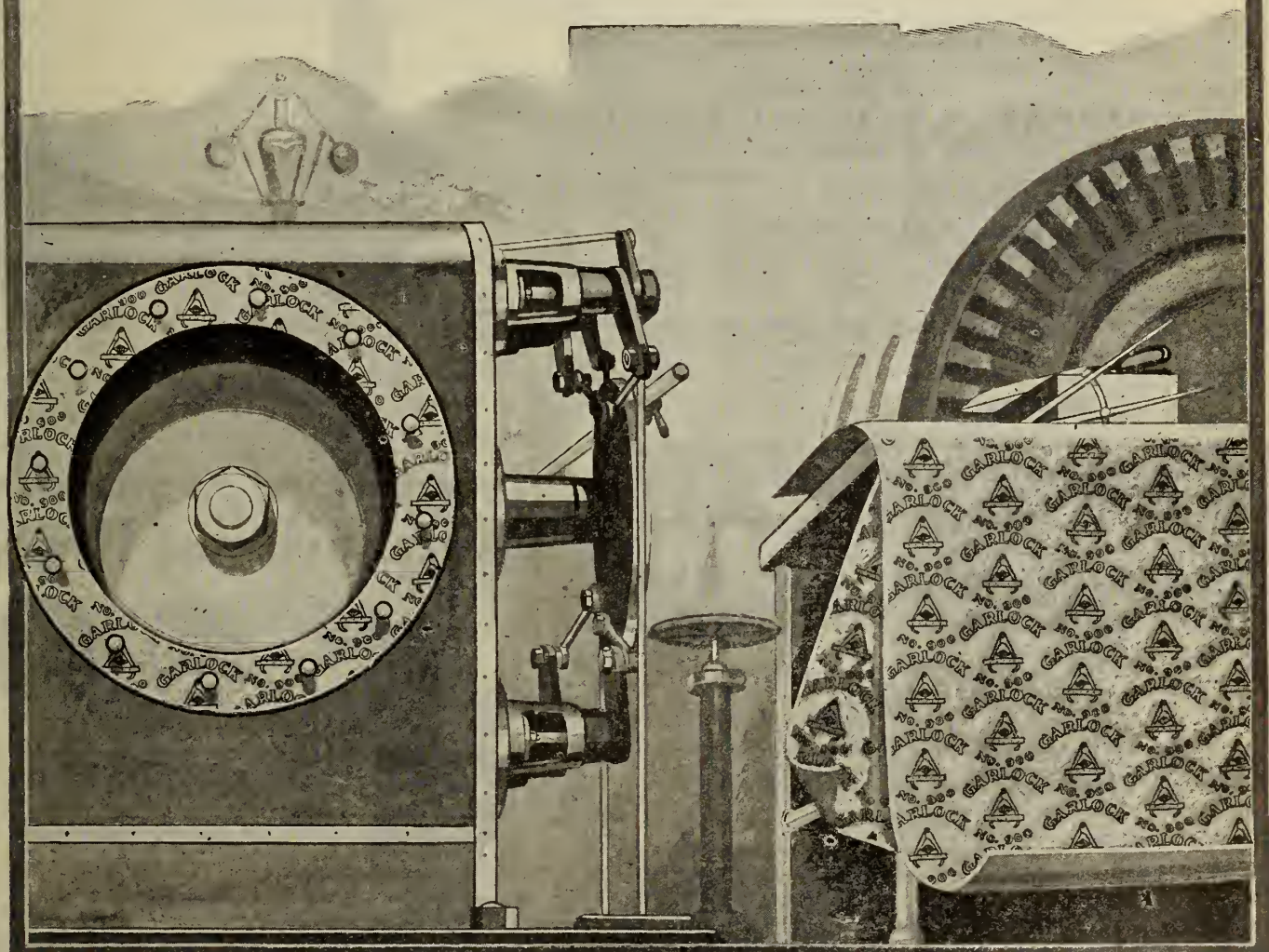
GARLOCK~No. 900
SHEET PACKING

The modern tendency in engineering is toward higher pressures and increased superheat. No. 900 sheet packing has met this continued advance and given entire satisfaction under severest conditions.

Due to its high tensile strength, No. 900 gives lasting service on joints that are frequently broken, and under strainer box covers or handhole plates that are often removed.

No. 900 is equally adapted to steam, air, ammonia, acids, etc.

The Garlock trade-mark is your guarantee of reliability.



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HAMILTON, ONT.
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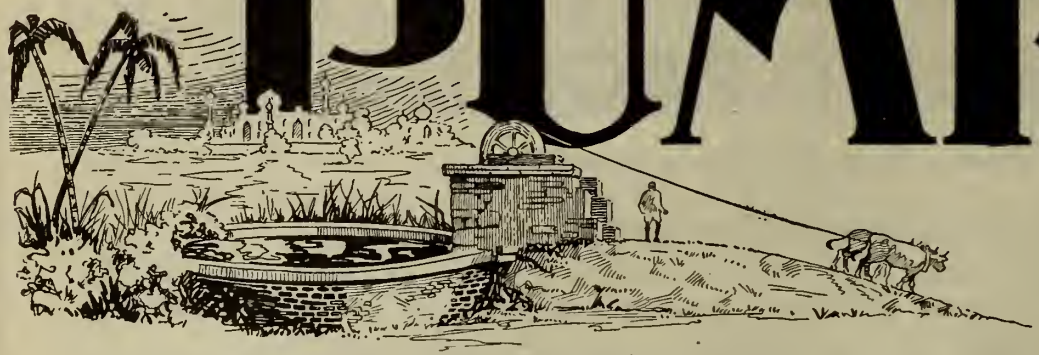
PUMPS



The ancient Indian Churras is a combination of rope, pulley, leather bucket, deep well, and a pair of oxen.

There was one good thing about the ancient Churras of India—it was reliable. The powerful oxen never seemed to tire. Every time they plodded down the hill they pulled from out the well a big bucket of water.

One of the many good things about American-Marsh Pumps is their absolute reliability. There are no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design.

Write for bulletins.

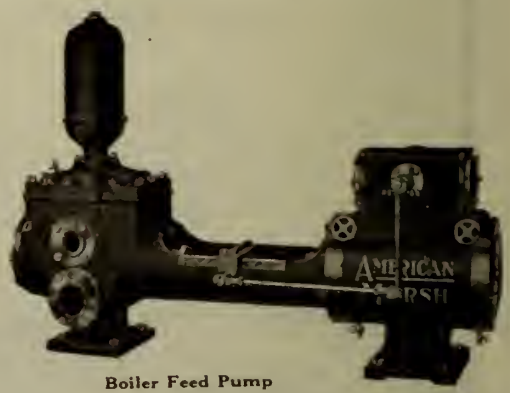
AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICH.

Chicago Office:
1220 Monadnock Block

New York Office:
17 Battery Place

CANADIAN AGENTS
A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London. A. R. Williams Machinery Co., Ltd., Winnipeg. Mechanics' Supply Co., Ltd., Quebec. Gorman's, Ltd., Edmonton and Calgary.

The American Marsh Lines also include Power Pumps, Compressors, Vacuum Pumps, Condensers, Deep Well Engines, Boiler Feed Pumps.

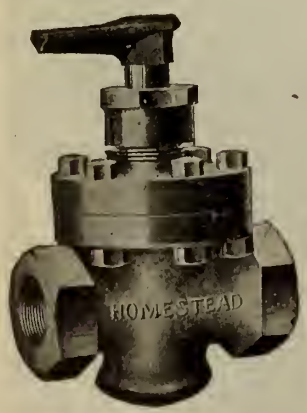


Boiler Feed Pump

HOMESTEAD Quarter-Turn Valves

Stay Tight!

It is practically impossible to keep globe or gate valves tight for any length of time when the service is severe because the seating surfaces are always exposed and subject to pitting and cutting.



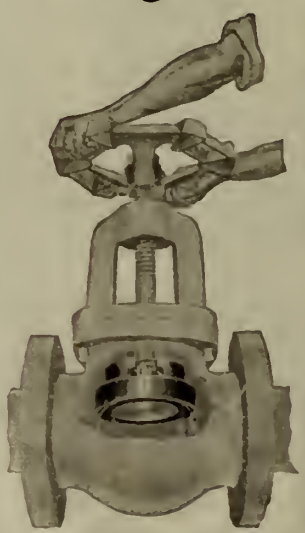
Homestead quarter turn Valves are seatless. They stay tight!

You can save yourself many a breakdown and many a shut-down by using Homestead Valves. They are guaranteed unconditionally and are rendering more than expected results to thousands of satisfied customers who back up their experiences by ordering more Homesteads whenever they require tight, efficient, durable, positive-acting valves.

Benefit by the experience of others. Give Homestead Quarter-Turn Valves a trial, and secure permanent satisfaction.

Homestead Valve Mfg. Company
Pittsburgh, Pa. : : Works: Homestead

Turn as hard as you can— They will not Break



A disc that breaks and drops from its holder not only causes a leaky valve but the loose parts as a rule clog the pipes and perhaps damage the pump or other apparatus to which the line is connected.
Be sure you specify **Pratt & Cady Renewable Disc Valves** because they are provided with asbestos discs with ample strength and heat-resisting properties.

P. & C. discs are of a fibrous structure—grade A asbestos, the longest fibre stock obtainable. These long fibres are closely interwoven, one with the other and firmly molded into a cohesive mass by the addition of a specially prepared binder.

Write for further particulars and catalog.

PRATT & CADY CO., INC.

Manufacturers of Valves and Asbestos Packed Cocks that give long and satisfactory service.
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PRATT & CADY
RENEWABLE DISC GLOBE VALVES

Superheating

Regardless of Fuel Cost, Even Though it Costs Nothing, it Pays to Superheat With Elesco Superheaters

No matter what your fuel costs, even though it costs you nothing, it pays to apply Elesco Superheaters to your boilers. Instead of wet, lifeless steam, your engines or turbines receive an ample supply of superheated "power plus" steam.

Where fuel costs are high you can reduce its cost by burning less of it. All your operating conditions will be improved when you apply Elesco Superheaters. Your steam supply will be adequate even under increased power demands; your piping and engines will be protected from the dangers of water hammer. Turbine blade wear will be greatly reduced and reblading necessary only after much longer periods of operation.

These advantages result in lower operating and maintenance costs.

Let us explain how the Elesco Superheater will accomplish these results in your plant.

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Transportation Bldg., Montreal **Works at Sherbrooke, Quebec**

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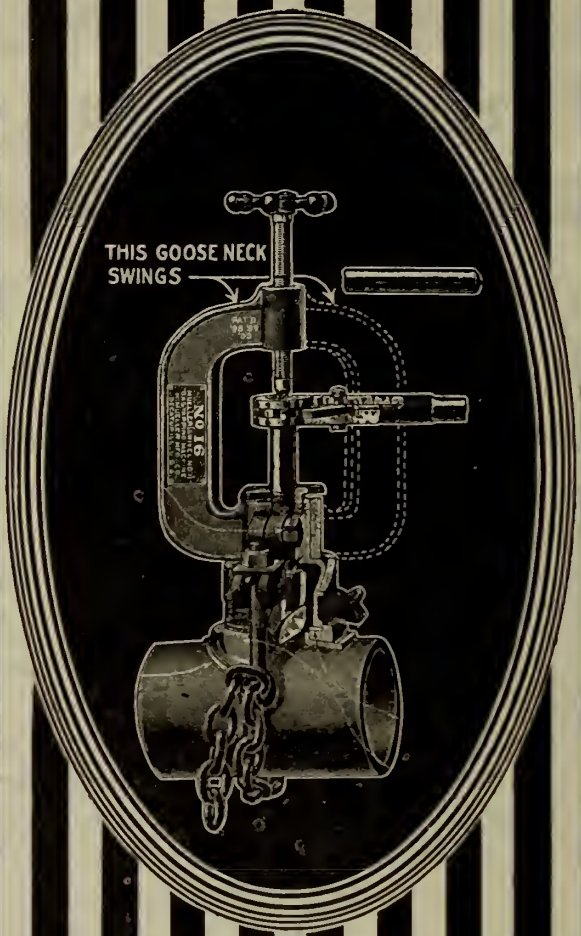

Mueller Tapping Machine No. L.

Makes taps from ⅜ to 2 inches in all sizes of pipes under pressure. The Goose Neck is swiveled, turning to any position to allow ease in operating the Ratchet Handle. The special Mueller Oiling Device supplies oil to the tool through the Gas Cylinder.

Mueller Gas Tapping Machines are made in eight different patterns for tapping open gas mains, or mains under pressure. Over 90% of Tapping Machines in use are Mueller built—proof of their efficiency and superiority.

Write today for detailed descriptions and prices.

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Water, Plumbing and Gas Brass Goods and Tools

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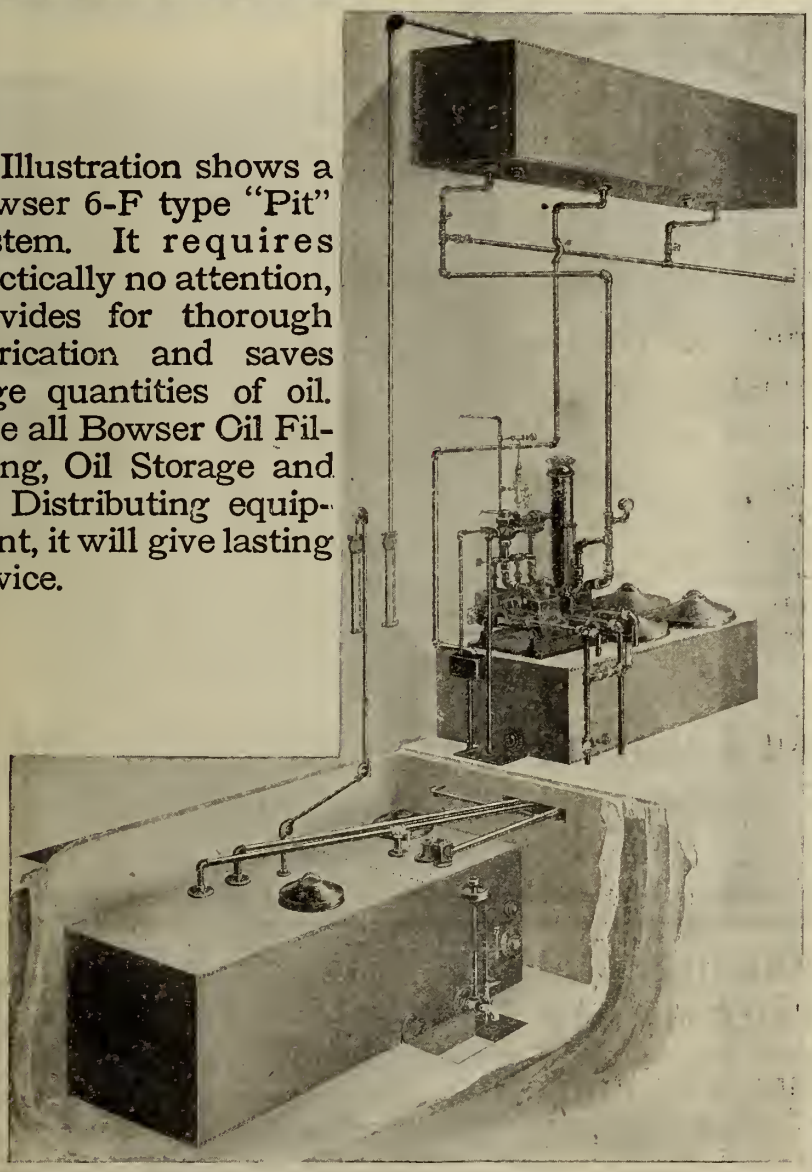
Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.

BOWSER OIL FILTRATION SYSTEMS

ESTABLISHED 1885

Illustration shows a Bowser 6-F type "Pit" System. It requires practically no attention, provides for thorough lubrication and saves large quantities of oil. Like all Bowser Oil Filtering, Oil Storage and Oil Distributing equipment, it will give lasting service.



provide the most efficient method of lubrication for rolling mill, gas or steam engines, for any moving part requiring lubrication.

The Bowser System provides plentiful lubrication at all times. It reduces the consumption of oil enormously by filtering and using the oil over and over. It increases production or power output by reducing friction and preventing breakdowns from worn out or burned bearings.

Let our engineers tell you of representative installations, suggesting how you can save by filtering your oil. Their co-operation and their experience is at your disposal.

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S. F. BOWSER COMPANY, Limited

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REFRIGERATING AND
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For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

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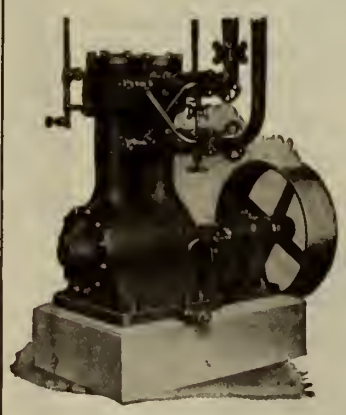

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Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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Our Machines are in daily operation in Canada

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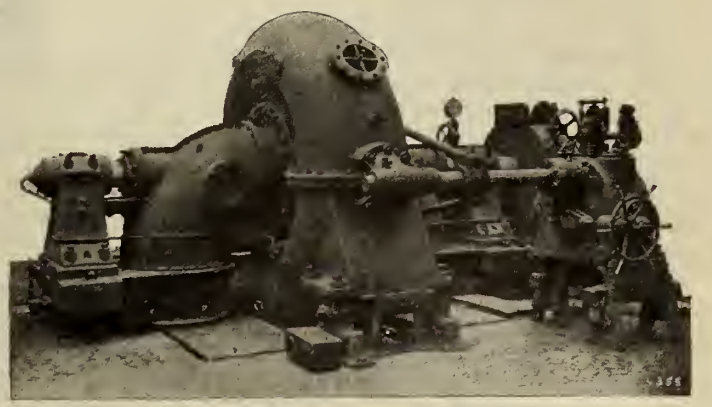

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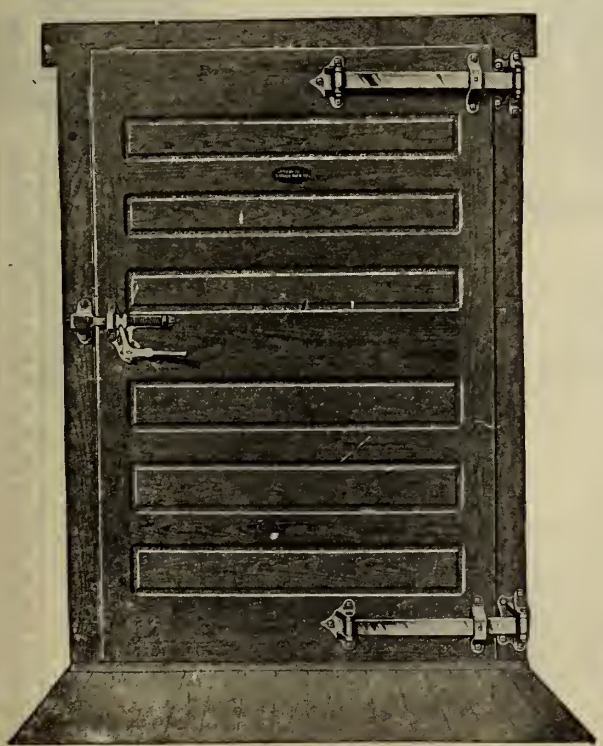

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

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"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

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The Cost of Frost

It costs as much in *one year* to keep brine and ammonia lines covered with frost as it does to insulate them permanently with Nonpareil Cork Covering. In other words, Nonpareil Cork Covering saves in one year, or less, enough refrigeration to pay for itself.

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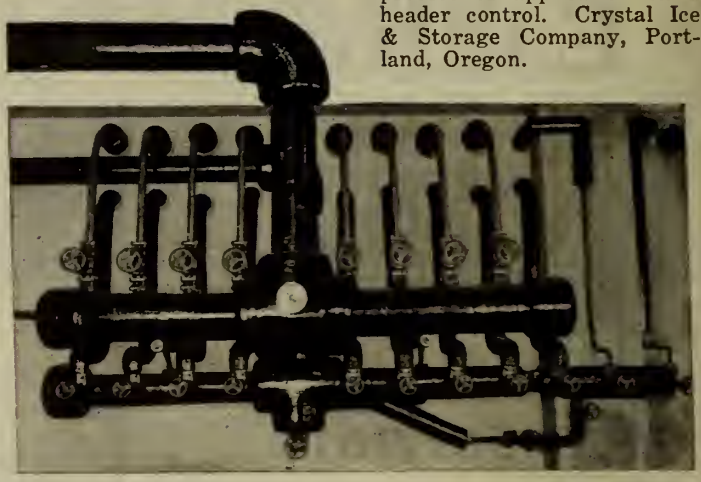
Nonpareil Cork Covering is composed solely of clean, granulated cork. Its insulating efficiency is due to the myriads of minute sealed air-cells of which cork is composed. Densely compressed in molds, moisture-proofed internally by the liquefied gum of the corkwood and protected externally by a mineral rubber finish, Nonpareil Cork Covering is impervious to moisture and frost. Properly applied and given reasonable care, it "lasts longer than the pipe."



Nonpareil Cork Covering in process of application on a header control. Crystal Ice & Storage Company, Portland, Oregon.

Some remarkably interesting and valuable information on cold pipe losses and the savings effected by insulation is contained in the 64-page book, "Nonpareil Cork Covering." Write for a copy. There is no charge or obligation and you will find it well worth while.

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The machine occupies a comparatively small floor space.

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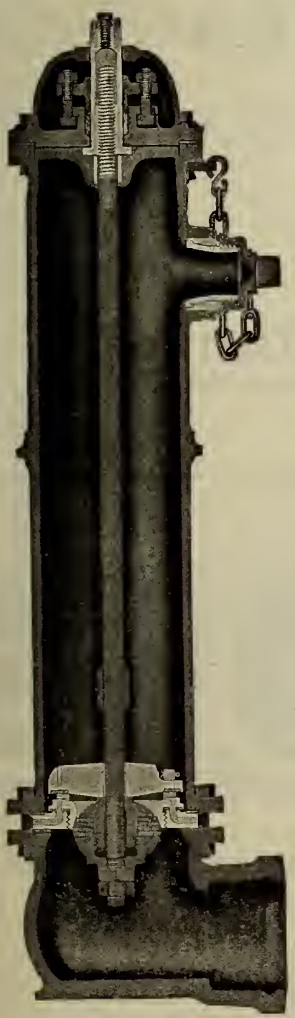

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Some of the Qualities of the DARLING HYDRANT

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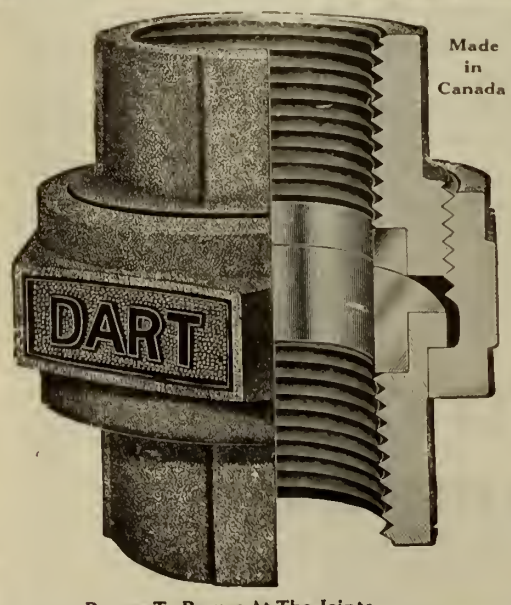

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REASON:—They are made of a low grade of short fibre asbestos, requiring cotton to hold them together, thus limiting the packing power to resist heat.
You can secure full money value from your packing if you use

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as it is made strictly of long fibre asbestos of the first grade and thoroughly lubricated.
USE THE BEST PACKING AND YOU ARE NOT CONSTANTLY REPACKING THE STUFFING BOXES.
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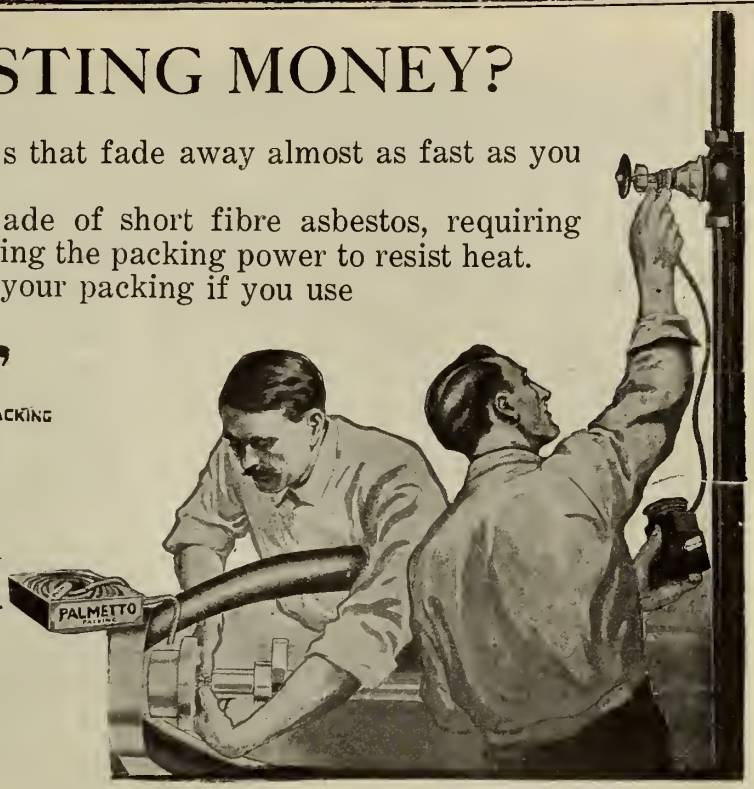

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Aeroplane View of the Berliner Gramophone Company's Plant, St. Henry, Montreal.

"His Master's Voice" People use Jenkins Valves

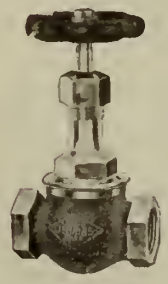

Fig. 106
Jenkins Brass Globe Valve
Standard Pattern

Successful manufacturers like the Berliner Gramophone Company realize the importance of dependable equipment at every point and, naturally, "Jenkins" is the choice wherever valves are used.

Many years ago Jenkins Valves were installed in the original Berliner plant and functioned so satisfactorily that the Company insisted upon similar valve equipment in the big new factory addition recently completed.

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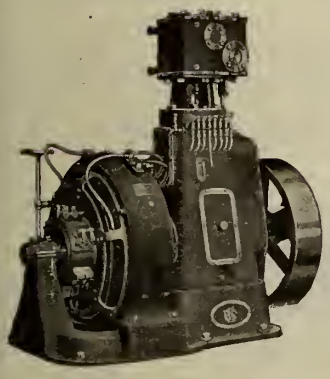

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Sturtevant (TRADE MARK) GENERATING SETS

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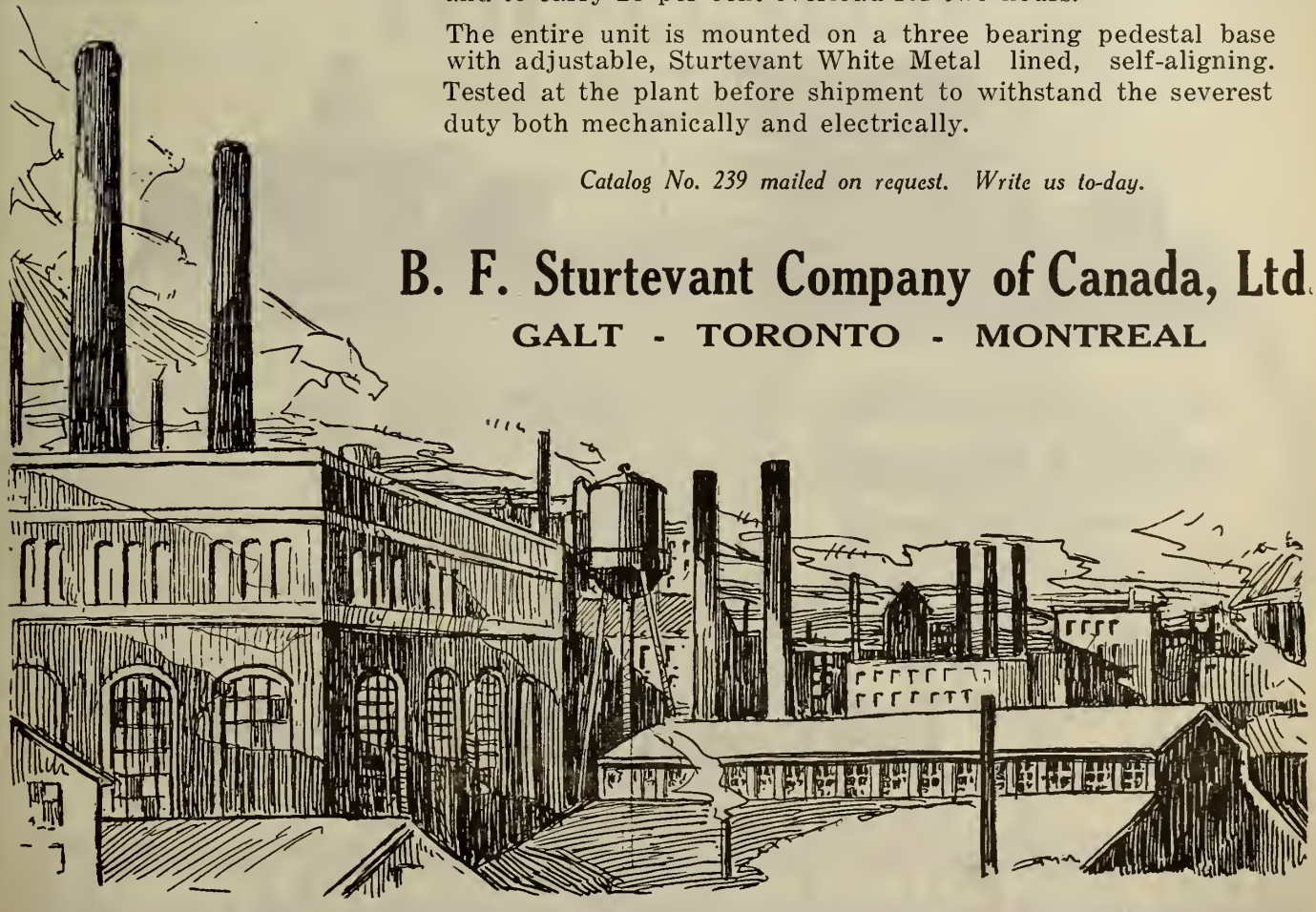

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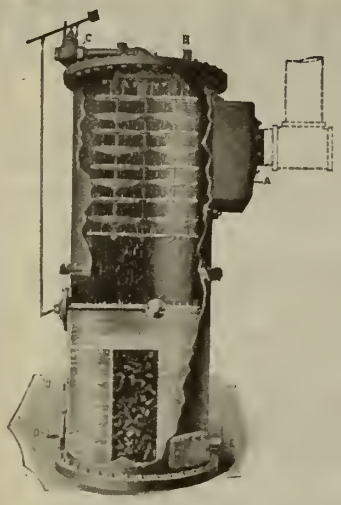

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SIMS CLEAN E-Z

Type B. H. Storage Heaters

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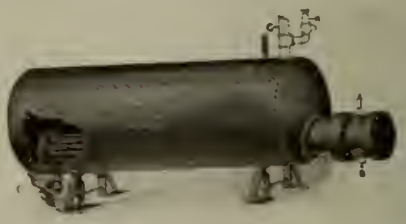

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Genuine British Oak Tanning applied by highly skilled workmen, adds strength and gripping power until, when finished, the oak leaf trade mark has become a guarantee of tough, pliable belting, just as stretchless as a leather belting should be. Belting whose hugging grip means the elimination of slippage.

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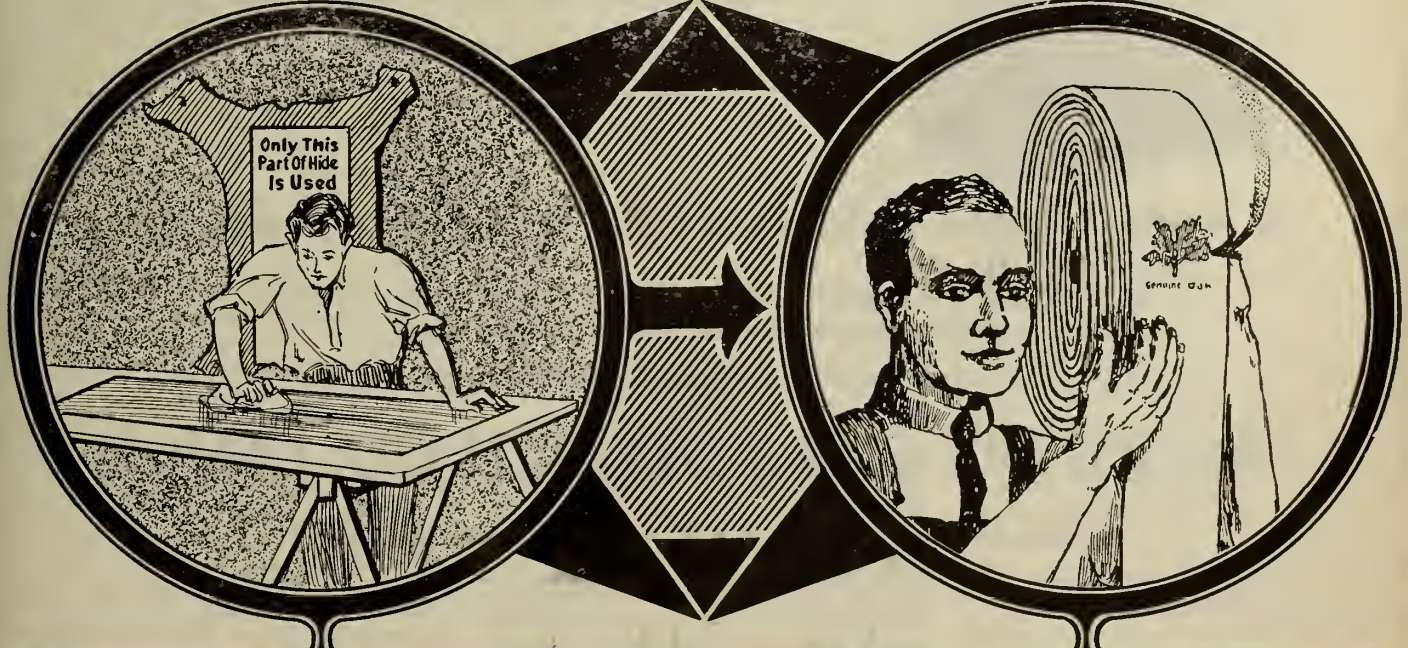

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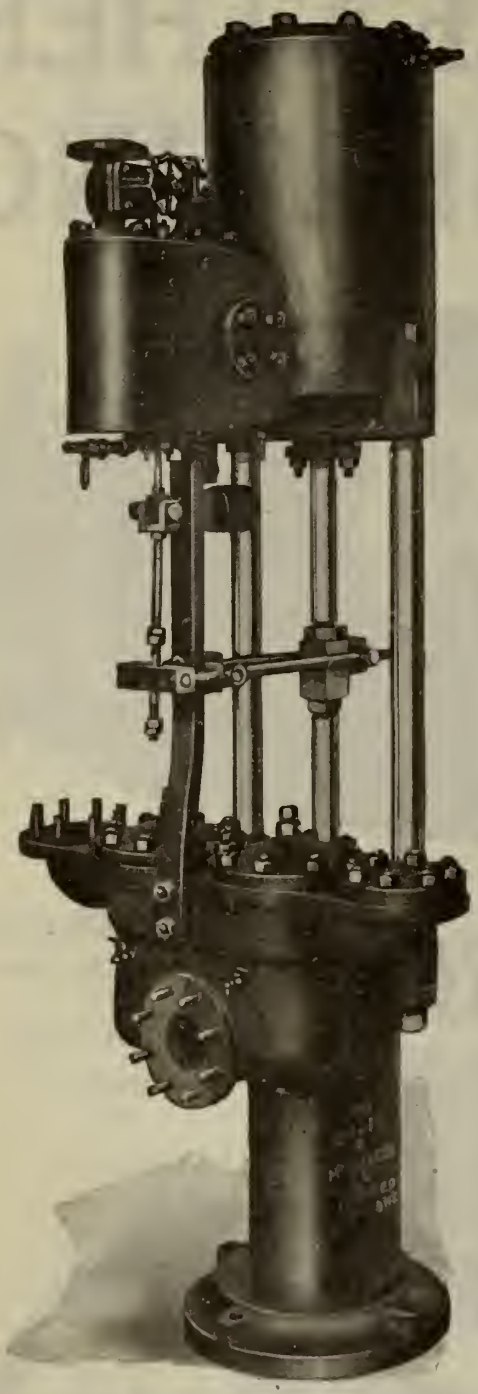

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Modern Boiler Room Requirements

frequently necessitate the installation of pumps which differ materially from the ordinary Horizontal Boiler Feed Pumps. These special requirements include large Capacity, the ability to handle water at high temperatures, the necessity of operating against high pressures, and when used in connection with Water Tube Boiler Pumps are required to give a regular, steady, slow feed and at the same time be ready to answer instantly to sudden demands for extra duty during periods of heavy load.

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Some Notes on the Burning of Oil Fuel

Analyses of Various Fuel Oils—Air Required for Combustion—Disadvantages of Inferior Burner of Low Cost—Mechanical Systems—Speed in Raising Steam on Idle Boilers—Boiler Furnace Design—Refractory Material

By J. A. McGILLIVRAY

IT IS not the writer's intention to enter into a discussion of the merits or demerits of the various oil burners now in use. There are a great many types, and probably thousands of patents that will never see the light of day. But there are two general classes that may be referred to as high pressure or mechanical, and low pressure burners.

High pressure or mechanical burners are supplied with oil under high pressure, atomization is mechanically produced, and the low pressure burners are supplied with compressed air or steam for atomization. With either type it is absolutely essential for complete combustion that the oil be broken up into fine spray (atomized) so that the oil and oxygen required for its combustion may mix in proper proportions and freely unite.

Ordinarily, high pressure air or steam is preferable to low pressure, as the atomization is more complete, but with low pressure types good results have been obtained with light oils. For stationary boilers steam from the battery at boiler pressure is used. The steam supplied must be free from moisture, not necessarily superheated steam, but dry, saturated steam. If the plant is equipped with air compressors, there is an advantage in using compressed air instead of steam for atomization. In fact numerous tests have proven that the evaporation is from 6 per cent to 12 per cent better per pound of fuel when compressed air is used, but the air pressure must be reasonably constant and this must be taken into account when installing the unit. It may pay to put in a small independent compressor to supply the burners, as in ordinary compressor plants the air pressure may vary 10 to 15 pounds in as many minutes. The writer has had some annoyance with this feature of compressed air supplied from the main air compressors for atomization. The volume of air required for combustion is not supplied entirely through the atomizer, only sufficient to break the oil up into its atoms. The volume for combustion is supplied either by natural draft or low pressure blower. If compressed air is used the pressure should be from 70 to 90 pounds per sq. in. for a high pressure burner, using ordinary crude oil.

The oil is, or should be, heated on its way to the atomizer to a temperature near the vaporizing point. The vaporizing point varies for crude oil from 142 deg. Fahr. to 230 deg. Fahr., and light fuel oil 130 deg. Fahr. This heating oil is often conveniently and economically accomplished by running oil supply pipe through a heated space in the furnace brickwork. The oil pressure will vary with the gravity of the oil, and may be anything from a few pounds per sq. in. to 400 pounds, depending upon the system used, but as already stated the air pressure and oil pressure must be constant and reasonably steady in order to get satisfactory results. With high viscosity crude oil it will be necessary to heat the oil in the supply tanks sufficiently to reduce its viscosity so that it can be conveniently pumped.

Some analyses of fuel and crude oils are given herewith, through the courtesy of William Newton Best, author of the "Science of Burning Liquid Fuel."

Analysis of Fuel Oil

Carbon	84.35%
Hydrogen	11.33%
Oxygen	2.82%
Nitrogen	.60%
Sulphur	.90%
Gravity	26 to 28 Baume
Weight per Amer. gallon	7.3 lbs.
Vaporizing point	130 deg. Fahr.
Calorific value	from 18,350 B.T.U. to 19,348 B.T.U.

Analysis of Beaumont (Texas) Crude Oil

Carbon	84.60%
Hydrogen	10.90%
Sulphur	1.63%
Gravity	21 Baume
Weight, per gal.	7.5 lbs.
Calorific value	19,060 B.T.U. per lb.
Vaporizing point	142 deg. Fahr.

Analysis of California Crude Oil (Heavy Oils)

Carbon	81.52%
Hydrogen	11.01%
Sulphur	.55%
Nitrogen) Oxygen)	6.92%
Gravity varies from	12 to 36 Baume
Weight per gal.	7.6 lbs.
Calorific value	18,462 to 20,680 B. T. U. per lb.
Vaporizing points	230 deg. Fahr.

Analysis of Mexican Crude Oil

Carbon	82.83%
Hydrogen	12.19%
Oxygen	.43%
Nitrogen	1.72%
Sulphur	2.83%
Gravity varies from	12 to 23.8 Baume
Weight per gal. (Amer.)	7.82 lbs.
Calorific value	18,493 B.T.U. per lb
Vaporizing point	175 deg. Fahr.

Air Required for Combustion

Theoretically, the amount of air required for complete combustion of fuel oils varies with its chemical composition and is for average fuel oils 14 pounds per pound of fuel and in volume=about 190 cubic feet per pound of fuel. In best practice, however, there is always some excess air, and the efficiency of combustion may be considered good if excess air does not exceed 30 per cent of the theoretical, or 18 1-2 to 19 1-2 pounds per pound of fuel.

Considering that the efficiency of the furnace begins to fall off rapidly with excess air over 30 per cent and that 100 per cent excess air is common, it is very important to have the settings airtight and the supply of air to the furnace under control through the proper channels, as the air that infilters through the settings does not properly mix with the fuel.

The aid of a gas analyser is essential in determining excess airs—and since it is highly important that the operator should know definitely at all times the amount of excess air being admitted a hand analyzer or portable set is unsatisfactory, as he has definite information for only the instant that the gas sample was taken. Also a great deal depends on the person taking the sample, and his knowledge of the instrument. It would therefore ap-

pear that a good recorder or indicator is really a necessity.

A study of the appearance of the flame is also of valuable assistance. It may be said that an experienced man can judge the amount of excess air pretty closely by studying the color of the flame. The following from Sterling's Marine Engineers' Handbook may be interesting:

"If the flame is incandescent white, and the furnace walls are clearly discernible through it there is considerable excess air present. As the percentage of excess air is reduced the color of the flame at the rear end of the furnace becomes a pale yellow, then yellowish orange and orange red. In general with an efficient installation operating under a minimum of excess air, the ends of the flame farthest from the atomizers are a yellowish orange, or golden shade. The gases of combustion are colorless and the seams in the brick are just discernible.

"At very high rates of combustion, when the flame completely fills the furnace, temperatures preclude the presence of these temperature colors. An incandescent dazzling white still indicates excess air, but a reduction in this excess is only indicated in the furnace by a softening in the intensity of the white flame."

Observation of the smoke pipe or chimney may be entirely misleading. A perfectly clear smoke pipe or chimney may mean only a small amount of excess air or it may mean as much as 300 per cent excess.

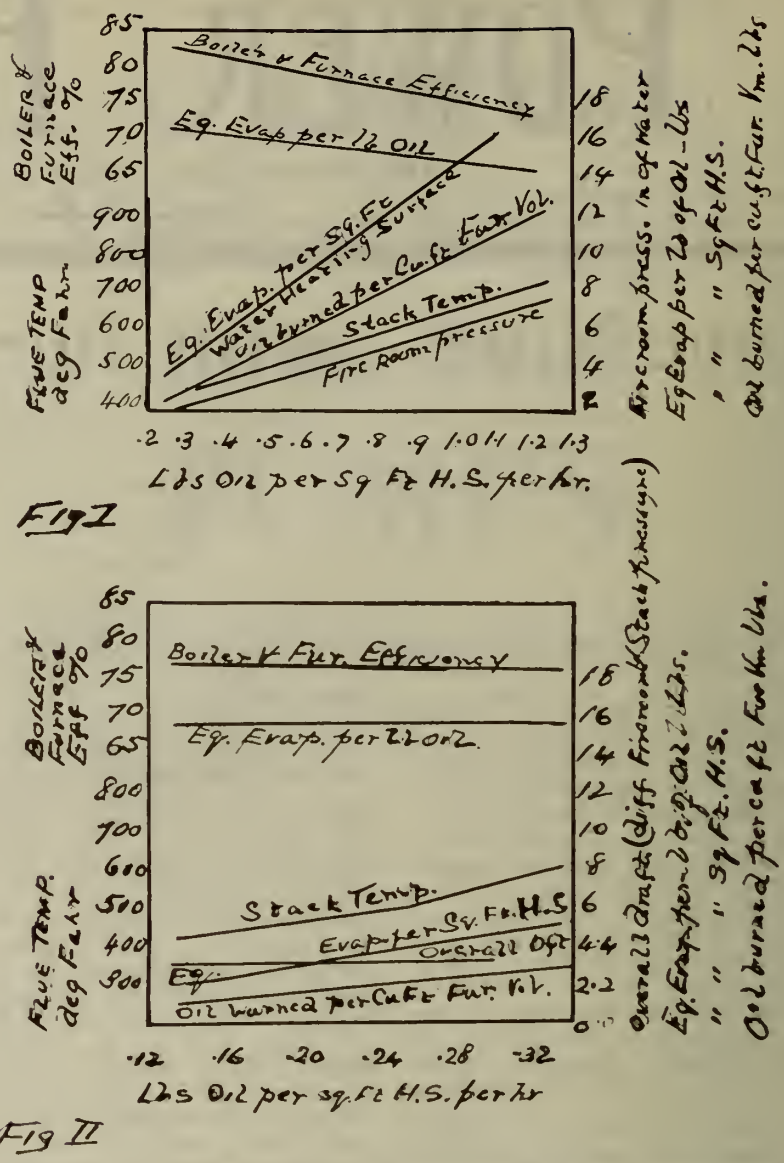
A clear smoke pipe is ideal when the gas analysis at the same time shows that there is high CO_2 very low O_2 and no CO. For example 14.7 CO_2, 0.8 O_2 and no CO.

It is well to remember that the presence of smoke does not always mean insufficient air or high CO. (1) an inefficient installation, (2) poor atomization; (3) poor mixture of air and oil; (4) unconsumed oil striking cooling surfaces and (5) poorly designed furnace frequently cause smoke when the air used for combustion may be far in excess of that required.

By far the most common causes for low efficiency are probably "poor mixture" and infiltration of air through the settings. The latter can be prevented by keeping the settings in good repair, and applying a coating of non-infiltration or other insulation. The former can only be improved by the installation of a good atomizer and proper control of the air supplied for combustion.

The great importance of properly mixing the air and oil may be more clearly demonstrated by another reference to Best's "Science of Burning Liquid Fuel."

"Considering that air contains 20.7 parts oxygen and 79.3 parts nitrogen at 62 deg. Fahr., one pound of air occupies 13.41 cubic feet. If the temperature is increased to 100 deg. Fahr. this air occupies 14.096 cubic feet. Theoretically it requires 13 1-2 to 14 1-2 pounds of air to effect perfect combustion of 1 pound of oil. Allowing 14 pounds at 62 deg.


Boiler & Furnace Efficiency
Eq. Evap per Lb Oil
Eq. Evap. per Sq. Ft Water Heating Surface
Oil burned per Cu. Ft Fur. Vol.
Stack Temp.
Fire Room pressure
Boiler & Furnace Eff. %
Flue Temp deg Fahr
Fire room press. in oz of water
Eq Evap per Lb of Oil - Lbs
" " Sq Ft H.S.
Oil burned per cu ft Fur. Vol. Lbs
Lbs Oil per Sq Ft H.S. per hr.
Fig I
Boiler & Fur. Efficiency
Eq. Evap. per Lb Oil
Stack Temp.
Evap per Sq. Ft. H.S.
Overall Eff
Eq.
Oil burned per Cu Ft Fur. Vol.
Boiler & Furnace Eff %
Flue Temp deg Fahr
Overall draft (Diff Fireroom & Stack pressure)
Eq. Evap per Lb Oil Lbs.
" " Sq Ft H.S.
Oil burned per cu ft Fur. Vol.
Lbs Oil per sq. ft H.S. per hr
Fig II

FIGS. 1 and 2. — Are from Tests conducted on the Experimental White Foster Boiler at the Naval Fuel Oil Testing Plant, Pa.

Fahr., it would require 183.97 cubic feet of air to effect perfect combustion of one pound of oil or at 100 deg. Fahr., it would require 197.34 cubic feet of air. In practice it requires 17 1-2 to 19 1-2 pounds of air to effect complete combustion of a pound of oil.

"Allowing 19 pounds of air at 62 deg. Fahr. This air occupies 249.68 cubic feet or at 100 deg. Fahr. it occupies 267.8[2] cubic feet. Allowing a gallon of oil to weigh 7 1-2 pounds, it requires 19 × 7 1-2 = 142 1-2 pounds of air to effect the combustion of one gallon of oil, or 1872 cubic feet of air at 62 deg. Fahr., or at 100 deg. Fahr., it will require 2009 1-4 cubic feet of air to effect complete combustion of a gallon of oil."

Now, to make it still clearer, let us consider Mr. Best's statement in terms of volume of air to volume of oil, remembering that the oil and air must be mixed freely and thoroughly.

A gallon of oil contains 231 cubic inches. The proportion of air to oil must then be, when the temperature is 100 deg. Fahr.

(2009.25 × 1728) to 231, or

$$\frac{2009.25 \times 1728}{231} = 15030.23$$

or with every unit of oil at 100 deg. Fahr. there must be mixed 15030.23 volumes of air at the same temperature, or in other words, the oil must be broken up by the force of the atomizing agent into approximately

$$\frac{1}{15030}$$

of its volume at the point where it issues from the oil feed nozzle. This is not dependent on any part of the installation at a whole, but entirely on the atomizer itself, its ability to break the oil up into its atoms. This is why some of the home-made burners to be found in use are extravagant and some of them are not worthy of a moment's notice.

Looked Good—But a Failure

Their first cost is low, to be sure, but their efficiency is zero. They can spray oil into the furnace in a fine mist, but they are not atomizers. A few of the home-made kind came to the writer's

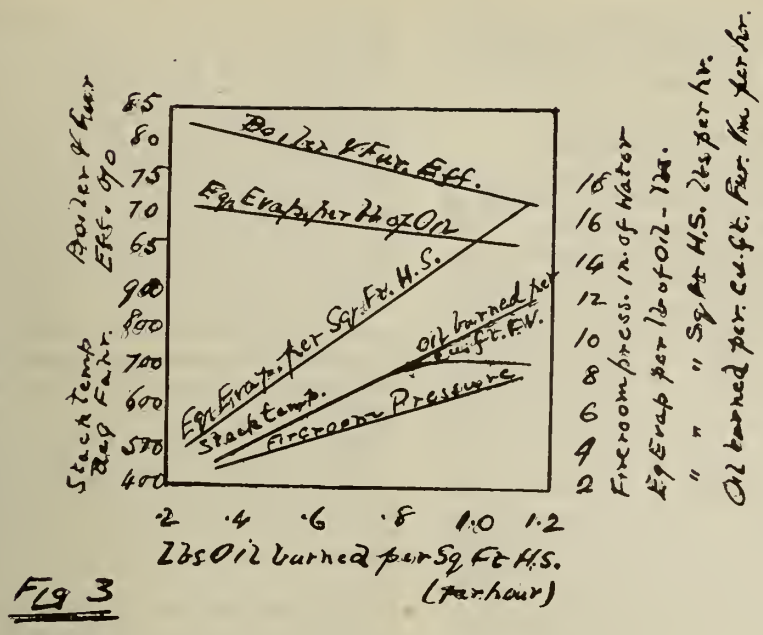

Boiler & Furn. Eff.
Eq. Evap. per lb of Oil
Eq. Evap. per Sq. Ft. H.S.
Stack temp.
Firerom Pressure
oil burned per sq.ft. F.V.
Boiler & Furn. Eff. %
Stack temp Deg. Fahr.
Firerom pressure in. of Water
Eq Evap per lb of Oil - lbs.
" " Sq. Ft. H.S. lbs per hr.
Oil burned per cu.ft. Fur. Vol. per hr.
Lbs Oil burned per Sq Ft H.S. (per hour)

FIG 3

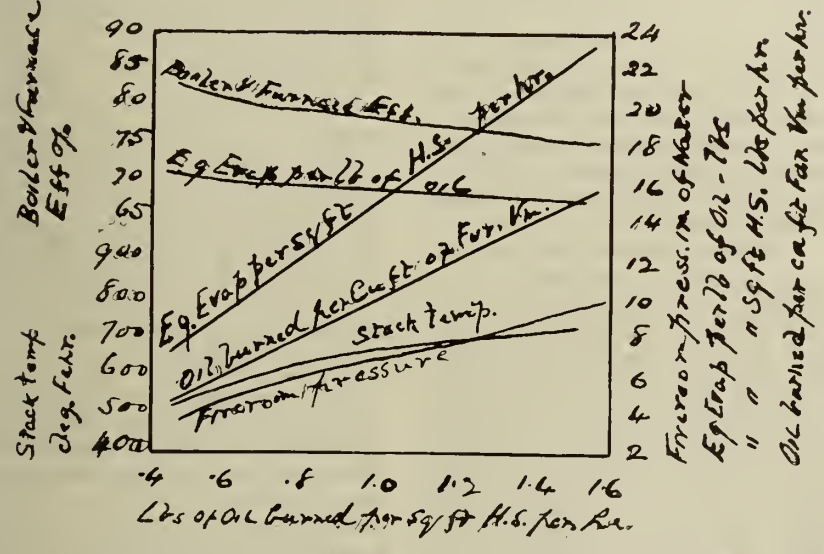

Boiler & Furnace Eff. %
Stack temp deg. Fahr.
Boiler & Furnace Eff. per hr.
Eq. Evap. per lb of H.S.
Eq. Evap. per sq ft
Oil burned per cu ft of Fur. Vol.
Stack temp.
Firerom Pressure
Firerom pressure in. of Water
Eq Evap per lb of Oil - lbs
" " Sq ft H.S. lbs per hr.
Oil burned per cu ft per hr.
Lbs of Oil burned per Sq ft H.S. per hr.

FIG. 4. — Test of White Foster Experimental Boiler Equipped With Peabody Register and Peabody Power.

FIG. 3. — Showing Results of Tests on a Babcock & Wilcox Boiler Under Natural Draft at Moderate Atomiser.

notice a few years ago. One of them invented by a combustion engineer of very high standing gave promise of being a success on small rivet heating furnaces, and also on long torpedo furnaces. The degree of attention that it attracted at the time was entirely due to the fact that the inventor was considered at that time a pioneer in the development of oil burners and pulverized coal burners. His atomizer was low in first cost and could be built out of pipe fittings; his theory was correct, but his patent burner as a commercial article, was a miserable failure. I have no doubt had he lived to carry his theory out in another burner he was contemplating he would have succeeded, as he had the theory of combustion down better than any man with whom I have been personally acquainted before or since. I have recently seen modifications of this burner that were being introduced by another who did not have the advantage of combustion engineering experience, but who was a pretty brainy draftsman. He succeeded in making the original burner more complicated, more expensive, but on the whole much inferior, as an atomizer, to the original article.

Some day some one who has some combustion theory and experience and some drafting ability, and a little imagination left over, will develop an oil burner that will automatically control the oil, air supply and steam pressure, and maintain exactly 14 per cent CO_2, while we sit back and read the moving picture magazine—well, why not—and possibly the manager would pay for the magazine again—why not? It would pay the manager to buy magazines for some firemen I met in my time and keep them away from the fire door once in a while.

Mechanical Systems

The pressure of mechanical systems differs from the compressed air or steam atomizers in that the oil is atomized by being forced through the atomizer at a high pressure. That is, the oil supply is under high pressure, which forces the oil through the system. The pressure varies with the gravity of the oil, and is such that the oil is forced through the atomizer at a high velocity, thus breaking it up. The oil is heated to about the vaporizing point by passing through a heater. The air for combustion is supplied through tuyeres or air registers on the boiler fronts or checker work.

Stationary coal burning boilers are sometimes partially equipped with oil-burning apparatus, to supplement the coal fires in case of sudden demand for peak loads. The economy of coal operation is not impaired in any degree. The oil burners are placed on the side of the boilers and are instantly available. In some plants ordinarily under coal fires using stokers boilers may be equipped with oil burners on swivels so that they can be swung from position at the side of the boiler and thus play their fire over a green bed of fuel. When the coal bed has been ignited the oil burner is swung out of position and the opening in the front closed up. This is a great advantage in quick starting or with coal that is hard to ignite on a chain grate.

It would appear to be of great advantage in stationary plants that are subject to large peak loads at certain hours of the day, to have a few boilers in the battery equipped with oil burners, instead of banking fires. Banking is somewhat costly and more or less unsatisfactory as it requires a longer time to get banked fires worked up than to get an oil furnace hot.

Will Take 10 Minutes

As boilers under banked fires (short bank) are seldom cut out of the line—unless they are equipped with non-return valves and cut themselves out—they are always hot and no serious results are encountered by forcing them into service quickly. The advantage of oil burners on some of the battery can be appreciated. Economy is not always a factor when an emergency calls for more boilers in the line. A boiler kept hot, that is, not connected in the line but with hot water constantly circulating through and having a gas pilot light burning can be put into service at 150 pounds steam in ten minutes.

The following tests made at the Naval Fuel Oil Testing Plant, Philadelphia, show somewhat higher efficiency than might be expected from good W. T. boilers with coal fired stokers. The evaporation per pound of oil is from 15 to 17 pounds, with an average not far from 16 pounds. The evaporation per square foot of heating surface is high, the boiler and furnace efficiency falling off as the draft pressure and the evaporation per square foot of heating surface are increased. The efficiency falling off about 1-2 per cent, while the evaporation per square foot of H.S. is increased 230 per cent, the eq. evaporation per pound of oil falling off 10 per cent. The efficiency is highest when the equivalent evaporation per pound of oil is about 16 pounds, and the equivalent evaporation per square foot of H. S. about 5 pounds. It will be seen by referring to the above charts that what is

true of coal fired installations is also true of oil burning installations. High ratings are attainable only at the price of efficiency. However, there are other factors that largely determine the choice of installations, whether they shall be coal or oil, and which will not be discussed here, but it may safely be stated that oil is now a strong competitor of coal in stationary, locomotive and marine plants. Oil installations are even now putting in their appearance, almost at the mouth of the coal mines, and are at present attracting considerable attention from power plant engineers.

Boiler Furnace Design

The ideal conditions for furnace design are as follows:

1—Sufficient furnace volume for total oil burned at the designed rate of combustion, which maximum may be taken as .75 pounds of oil per sq. ft. of H. S. per hour in water tube boilers of large size, and the average may be stated to be .6 pounds per sq. ft. H. S. furnace volume.

The furnace volume should be 1 cu. ft. for every five pounds of oil burned per hour, for example—

A W. T. boiler, having 6000 square feet of H.S., the maximum rate of combustion .75 pounds per square foot of H.S., the volume of the furnace should be

$$\frac{6000 \times .75}{5} = 900 \text{ cu. ft.}$$

2—The maximum of refractory surface to assist in maintaining a high furnace temperature.

3—Increase of cross sectional area of the furnace with the expansion of the gases.

4—Minimum area of cooling surfaces close to the flame tending to reduce the furnace temperature.

5—Walls and tubes sufficiently remote from the burners to permit of complete combustion of oil before coming in contact with them.

6—A minimum of infiltration of air except through the proper channels.

7—Exit of the gases of completed combustion at a maximum distance from the burner.

Refractory Material

Poor fire brick should never be used as it is disappointing to both the builder and owner of the furnace. It takes as much time and labor to construct a furnace of poor fire brick as of good. Poor brick is dear at any price, no matter what may be the fuel used.

The excessive heat which can be obtained from liquid fuel makes it necessary in many instances to use a very superior grade of fire brick. These bricks must be non-expanding. Ordinary silica brick is not suitable for extremely high furnace temperature.

The analysis of brick for crucible furnaces is as follows:

Silica	56.15%
Alumina	33.925%
Peroxide Iron	0.59%
Lime	0.15%
Magnesia	0.115%
Water and inorganic matter	9.68%

In ordinery boiler furnaces it is not necessary to use such good quality of brick. It is, however, essential that the bricks do not expand or contract excessively.

Practical Requirements

The following instructions cover the putting into service and the operation of oil burners in a general way. They should be a guide for the fireman or operator who may have oil burning apparatus on his boilers or furnaces and whose duty it is to get the best results attainable. These instructions might well be written in every engineer's note book, whether he has to do with oil burning apparatus or not, at the present time, he may later on.

The oil must be finely atomized just prior to coming in contact with the air for combustion. The requisite quantity of air must be intimately mixed with the oil and excess air reduced to a minimum. A high furnace temperature must be maintained, by the use of sufficient refractory surface, to assist complete combustion.

Combustion must be completed before the combustible gases come in contact with the cooling surface and become chilled below the ignition temperature.

Boiler heating surfaces must be protected from localized heating caused by blow pipe action; heating should be uniformly distributed.

Before Lighting Fires

Ensure that the whole system is clean and free from dirt, waste, flakes of shellac, red lead, etc. Inspect and clean all strainers. This should be done frequently while under way. See that the wire gauze is in good condition and that the proper mesh is used. Thoroughly clean the atomizing tips, place and properly adjust same in air registers. Close individual atomizer throttle valves. Drain the water in the oil tanks that has separated and settled in the bottom.

If the oil is very cold and viscous, and the pumps have difficulty in getting a suction, use heating coils provided in the tanks. If air chambers are provided, drain and charge with compressed air.

Start up the pumps and put oil pressure on the lines. Inspect for oil leaks. If there is a meter provided in the oil line by-pass it until ready to light up, otherwise it will operate while air is being pumped out of the line and while oil is being circulated. Warm the oil with the heater. See that torch is ready. If light oil is being used, everything is in readiness for lighting the fires as no trouble is experienced in atomizing oils about 23 deg. Baume at the usual temperatures. When no steam is available a hand pump may be used, or motor driven auxiliary, where available in stationary plants.

A suitable lighting torch may be made by securing a few loose turns of asbestos wicking on the end of rigid wire rod.

Dampers should be wide open before fires are lighted.

Lighting Fires

Note that there is sufficient pressure on the oil and that it is at the proper temperature for good atomization. Light the torch and place near and just under the atomizer. Stand clear as a precaution against blow backs. Open the atomizer throttle and the oil will immediately light up and readily burn. Be sure to note that the oil is being properly atomized. A dirty atomizer will cause heavy black streaks. The presence of considerable water is indicated by sputtering, that is easily detected.

Every precaution should be taken to prevent unburned oil from collecting in the furnace, as the hot brick gasifies it and there is serious danger of a violent explosion.

When extra burners are lighted, it is preferable to use the torch each time while the furnace is still relatively cold. After steam is generated and the furnace is hot, additional burners may be safely lighted from adjacent burners in operation.

No matter how hot the furnace may be, if all the burners are temporarily secured, do not attempt to relight from incandescent brick work. The most serious accidents have been occasioned by this practice.

It is not advisable to raise steam too quickly as it is not only injurious to the boiler but it is hard on the refractory lining tending to spall and loosen the brick.

In special cases, such as some types of marine boliers on special craft and on fire engines it is permissible to raise steam rapidly, but with ordinary stationary or marine in ordinary operation it is bad practice and inexcusable.

Pressure on Oil

The oil pressure does not enter into the problem of burning different oils. The question is purely a matter of ascertaining the temperature requisite in the case of each grade of oil to obtain the proper viscosity. When this viscosity is maintained the oil pressure may be the same with every grade of oil. With atomizers properly designed and kept properly cleaned oil pressures from 125 to 250 pounds give practically equally good atomization. Increasing the pressure above 125 pounds merely increases the capacity which, other things being equal, is very nearly proportional to the square root of the pressure, i.e., to double the capacity, "the viscosity and the size of the orifice remaining the same," four times the pressure is required. With increased capacity the air pressure must also be increased.

Heavy Soot on the Tubes

Heavy deposit of soot on the tubes always accompanies smoking, no matter what kind of oil is used, and is a sure sign of incomplete combustion. This condition is exaggerated under natural draft and at low air pressures and may be due to several causes—insufficient air for combustion, poor atomizers, oil too viscous, atomizers improperly adjusted, poor design of installation, unstrained oil, etc.

Carbon on Atomizing Tips.

Carbon on atomizing tips is the surest sign of their improper location. If the

atomizer is shoved in too far, an eddy is formed in the entering air currents.

A fine fog of oil is drawn behind the face of the tip and is deposited on this face, on the side of the tip and occasionally for some distance back on the burner pipe. This latter is an extreme case, when the atomizer has been shoved in several inches beyond the proper point. In extreme cases jets of ragged flames are also drawn back by this eddy, sometimes completely hiding the tip from view.

Carbon on Furnace Openings

If carbon forms on the edges of the furnace openings, the atomizers have been drawn back too far, or as is often the case, the furnace opening is irregular due to patching up of the brick work, and edges of brick or mortar project into the outer film of the cone of oil. If carbon forms on atomizing tips and also on furnace opening and there are no mortar or brick projections, the opening has been reduced to such an extent that the burner cannot be drawn back far enough to prevent eddies in the air currents described above. This is a fault of design and can be eliminated by increasing the furnace opening or by a new design of air register.

Hard Deposits on Tubes and Furnace Sides and Bottom

Hard deposits on tubes and on furnace sides and bottom are due to the oil striking the tubes or brick before it has time to burn. This is caused by faulty design or operation.

Under faulty operation the causes are the same as those that produce excessive smoke and soot. These are the failure to obtain proper mixture of the entering air and oil, at the register. This is more often caused by improper location of the atomizing tips than anything else. It is sometimes due to too much excess air entering around the cone of oil and thereby cooling the flame down so that combustion is not obtained until some distance in the furnace. This permits the angles from the axis of the tip to strike particles of oil thrown off at the greater the furnace bottom, side walls, or tubes near the front of the furnace before they are burned. This cools them below the combustion temperature. The lighter gases vaporize and burn, the carbon remaining adheres to the surface as a solid.

The noticeable increase in the amount of carbon deposits when viscous oils of asphaltic case, such as Mexican and Californian, are burned, is probably due to the large proportion of unsaturated hydrocarbons contained. These are heavy and slow burning. Other things being equal, they require a longer time in which to become completely consumed. Therefore they require a longer combustion or some means must be resorted to that will hasten combustion. This can be accomplished by increasing the velocity of the entering air for combustion. The area of the openings in the air controlling registers must be closed a proportional amount so that the volume remains the same. It is frequently stated by engineers that more air is needed to burn Mexican oils. This is not correct, and should be stated as follows: A greater pressure is required to burn Mexican oils, as an increase in pressure is necessary to obtain an increase in the entering velocity.

Water Power Resources of Canada

DURING the past two years there has been under way in the Dominion Water Power Branch a careful re-analysis and computation of Canada's water power resources. All existing stream flow and power data, available from Dominion and Provincial sources, have been systematically collated, analysed and co-ordinated with a view to preparing on a uniform basis from coast to coast, revised estimates of the power available. While the analysis is not yet finally completed, sufficient progress has been made to warrant the publication of the figures herein.

The total available and developed power resources are presented in a manner not heretofore adopted. A consideration of the figures will indicate that they place the water power resources of the Dominion in a much more favourable light than have previously published compilations.

While the resources have been exhaustively analysed in so far as the information available will permit, it should be kept in mind that only very meager data are to hand in many districts and for many rivers.

Basis Of Computation

The figures listed in the accompanying table and diagram are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely known or at least well established. Innumerable rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations, which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record.

In brief the figures hereunder are based on definite rapids, falls and power sites, and may be said to represent the minimum water power possibilities of the Dominion.

The power estimates have been calculated on the basis of 24-hour power at 80 per cent efficiency on the basis of "Ordinary Minimum Flow" and "Estimated Flow for Maximum Development." The "Ordinary Minimum Flow" is based on the averages of the minimum flow for the lowest two consecutive seven day periods in each year, over the period for which records are available. The "Estimated Flow for Maximum Development" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method to determine this flow is to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum for the year. The average for such figures for all years in the period for which data are available is the estimated maximum used in the calculation.

The estimated maximum development is based upon the assumption that it is good commercial practice to develop wheel installation up to an amount, the continuance of which can be assured during six months of the year, on the assumption that the deficiency in power during the remainder of the year can be profitably provided from storage or by the installation of fuel power plants as auxiliaries. The correctness or otherwise of this assumption for any particular site can only be definitely settled by the careful consideration of all circumstances and conditions pertinent to its development. The method, however, enables us to make a fairly satisfactory overall estimate of the maximum hydraulic power available, as distinctive from the estimated ordinary minimum power available.

Available And Developed Totals

The recorded power available throughout the Dominion, under conditions of ordinary minimum flow and within the limitations set out in the foregoing, is 18,255,000 h. p. The water power available under estimated flow for maximum development, i. e., dependable for at least six months of the year is 32,076,000 h. p.

There are installed throughout the Dominion water wheels and turbines to the extent of 2,271,000 h. p. However, it would not be correct to place this figure in direct comparison with the minimum or maximum available power figures quoted above and therefrom deduce the percentage of the available water power resources developed to date. An allowance must be made for the average ratio between the water wheels installed and the power available.

An analysis of the water power plants scattered from coast to coast, concerning which complete information is available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30 per cent greater than

(Continued on page 37.)

The Treatment of Boiler Feed Water

Correcting Bad Water—Determination of Hardness, Scale, Foaming and Priming, Corrosion—Sources of Water Supply—Condensate—Requirements of Ideal Water Purification Plant

By ROBERT JUNE

HAVE YOU ever visited a salt plant? If so, you must have watched with interest the processes of evaporation in the salt pans. The brine enters the pans as a clear liquid, but as soon as heat is applied, the water begins to disappear in steam, and the salts are deposited. As you watched the deposits of salts increase, did it occur to you that an identical process to that going on before you was constantly going forward in your boilers?

In the case of the boiler the entering water is not loaded with the same high percentage of salt, to be sure, but the quantity of impurities is higher than is generally appreciated, and when you consider that there are literally many tons of water evaporated in the average boiler every day, and all the various salts and other impurities carried into the boiler remain until some definite action is taken to effect their removal, the fact becomes apparent that in dealing adequately with the impurities in water, we have a problem of real magnitude.

The importance of boiler water treatment is indeed not generally realized, because the size of the operating losses resulting from failure to remove or neutralize impurities in the feed water is not understood. These losses are caused by the formation of scale which reduces boiler efficiency and capacity, and by the pitting and corrosion of boiler tubes, which makes necessary their replacement.

In addition to causing scaling and corrosion, bad water causes foaming or priming. These troubles are self evident. There are other troubles, however, which are due to bad water and which are not so apparent. The good or bad condition of pump valves, and connection and feed lines, is largely dependent upon the quality of the water used, a fact which becomes evident when we suddenly lose the feed to a boiler, and perhaps the boiler or a good part of it. Nor do we always directly connect the breaking of a piston rod, cross head, or cylinder head with excess causticity or precipitates mixed with steam. Other losses which may often be traced to bad water are gradually increased steam consumption, excessive wear on packings and moving engine parts, and increased lubrication.

While these losses may not always be directly traced back to boiler feed, it is a fact that when our water is constantly purified there is very much less likelihood of these troubles occurring.

Correcting Bad Water

The neutralization or elimination of impurities in feed water may be effected by one or more of the following methods:

1—By chemical means.
  (a) Boiler compounds.
  (b) Water softening plants.
2—By mechanical means.
  (a) Tube cleaners.
  (b) Blow off.
  (c) Filter plants.
3—By thermal treatment.
  (a) Feed water treatment.
  (b) Distillation plants.

Before discussing these means of removing trouble, let us inquire further into the sources of our difficulties. We find that our troubles and their causes are as follows:

Scaling—Caused by the presence of sediment, mud, clay, readily soluble salts, bi-carbonate of magnesia, lime, iron, sulphate of lime, organic matter, etc.

Corrosion—Caused by the presence of grease, organic matter, chloride or sulphate of magnesium, sugar, acid, dissolved carbonic and oxygen, and also by electrolytic action.

Priming—Caused by the presence of sewage, alkalis and carbonate of soda in large quantities.

F. J. Crolius, steam engineer of the Carnegie Steel Co., classifies the various inorganic impurities in the manner shown in Table 1.

—By chemical means.

With the addition of chlorine, the combination given in the table cause most of our troubles. It is evident that the causes of so-called permanent hardness fall entirely within the sulphate range, and as a matter of fact most of our efforts must be directed towards the reduction of sulphates.

The principal scale forming offenders, $CaSO_4$ and $MgSO_4$, are non-corrosive, and the simplest procedure is to convert them to $NaSO_4$ and Ca or Mg carbonates, which are insolubles, by the addition of sodium. The sulphates of iron, aluminum and copper are usually so low that they can be ignored. This is fortunate as their removal usually requires expensive treatment.

Determination of Hardness

A 100-cc (cubic centimeter) sample of water to be tested is put in a 250-cc bottle, and a standard soap solution (this may be obtained from chemical dealers) run in 0.2 cc at a time, the bottle being shaken vigorously after each addition of the soap solution. Finally a lather is produced that will persist for at least five minutes, and then the volume of the soap solution used in cc. gives the degrees "U.S." hardness. One degree "U. S." hardness is equivalent to 1 grain of calcium carbonate per U. S. gallon (1 part in 58, 349.)

Professor Gebhardt employs the following factors for specifying the hardness of water in terms of calcium carbonate per U. S. gallon:

Magnesium carbonate	x 1.19
Magnesium sulphate	x 0.833
Calcium sulphate	x 0.735
Magnesium chloride	x 1.05
Calcium chloride	x 0.901

=hardness as calcium carbonate, grains per U. S. gallon or U. S. degrees.

It is impossible to judge the quality of feed water merely by the grains of solids per gallon since a large amount of soluble salt such as sodium chloride will not be as deleterious as a very small amount of calcium sulphate.

The scale of hardness usually accepted (grains of dissolved salts per U. S. gallon) is as follows: soft water, 1 to 10; moderately hard, 10 to 20; very hard water, above 25.

The following is a rough rating according to the number of grains of incrusting solids per United States gallon:

Less than 8 grains	very good
12 to 15 grains	good
15 to 20 grains	fair
20 to 30 grains	bad
Over 30 grains	very bad

This applies to calcium carbonate, magnesium carbonate, and magnesium chloride. For water containing sulphate of calcium and magnesium, divide the first column by four for the same rating.

The limiting factor in deciding whether a water carrying a large amount of soluble salts may be used for boiler feed purposes is the amount of blowing down necessary to keep the degree of concentration within the limits found by experience.

By the use of proper methods we may accomplish the complete removal of permanent hardness, oil, grease, and suspended matter, and may neutralize all their acids. The feed water may be so purified as to contain less than 1 1-2 grains per gallon of hardness due to calcium carbonate and magnesium hydroxide. The total of encrusting substances including silica, may be so reduced as to be less than 2 grains per gallon. This is the standard of purification which can usually be obtained and towards which we should work.

Scale

The character of scale varies from that of a porous, friable crust, to a dense, very hard coating. The amount of impurities present in the water cannot be used as a basis for pre-determining the amount of scale which will be formed, as this depends on the type of boiler, rate of driving and the nature of the scale forming ingredients.

In Table II. we have the results of a

number of tests made on locomotive boiler tubes with different thicknesses and character of scale. The variations in conductivity show the futility of basing any calculations on the thickness of scale. Thus test No. 1 shows a decrease of conductivity of 9.1 per cent for a scale 0.02 in. thick, while No. 16 shows a decrease of only 6.75 per cent for a scale over 6 1-2 times as thick. In each case the scale was even, hard and dense.

Influence of Scale on Heat Transmission

No.	Thickness of scale, inches	Character of scale	Dec. in conductivity, due to scale Per cent.
1	.02	Hard, dense	9.1
2	.02	Hard	2.02
3	.033	Soft	4.3
4	.033	Very hard	3.5
5	.038	Medium	4.03
6	.04	Soft, porous	6.82
7	.04	Hard, dense	3.07
8	.042	Very soft	9.54
9	.047	Hard	2.75
10	.065	Medium	2.39
11	.07	Soft	2.38
12	.07	Hard	4.43
13	.085	Soft, porous	19.0
14	.089	Very soft	4.95
15	.11	Hard, porous	16.75
16	.13	Hard, dense	6.75

The presence of scale, however, does cause material reduction in the heating surface, and in the volume of water held in the boilers. Thus a 4 in. boiler tube when clean, has an internal area of 141 square inches per foot of length, but should this tube become lined with one quarter inch of scale its area per foot of length is reduced to 122 square in. We thus find that a quarter inch of scale reduces the actual heating surface by about 11 per cent, and the volume of water by about 12 per cent. Furthermore the reduced area of the tubes tends to retard circulation.

Overheating of boiler tubes is the result of the presence of scale. When the deposit is heavy the tubes in the hottest passes of the boiler may become so hot that the pressure will bulge the metal to such an extent that the burst tube has the appearance of having been drawn. Overheating, even to a moderate degree, may cause gradual crystallization of the steel so that it eventually becomes brittle and can be broken like ordinary castings. The bursting of tubes is one of the most dangerous factors connected with the operation of water tube boilers and as it can always be traced to the presence of scale or oil on the internal surfaces, it follows that from the standpoint of safety and economy such conditions should not be tolerated.

Foaming and Priming

When foaming occurs it can usually be traced to the presence of one or more of the following impurities: Emulsified oil and grease, soluble organic matter, and silt in suspension. It may, however, be due to improper methods of handling the boiler, such as irregularities of load, improper firing and feeding, neglect to make periodic changes of water within the boiler, or to improper design of boiler, wrong arrangement of steam piping, incorrect water spaces or steam liberating area.

It is frequently claimed by operating engineers that the direct cause of priming and foaming in boilers is the presence of sodium salts in the feed water, and, of the sodium salts, sodium carbonate or soda ash, is the one most often charged with causing foaming. The trouble in such cases, however, is not due to the soda ash, but to the wrong application of it. It will usually be found that where foaming occurs with soda ash, no provision is made for the removal of precipitates formed by its reaction with the scale forming substances in the water. The result is the water becomes so befouled with impurities that priming and foaming occur.

Foaming may be caused by the introduction of soda ash in an open heater, which receives more or less animal oil with the exhaust, and the mixture of this organic oil with water containing sodium carbonate produces a soapy emulsion in addition to lime and magnesium precipitate.

Corrosion

Corrosion is evidenced by small pits or depressions and by large cup-shaped hollows on the metal surface, and occasionally by a considerable destruction of a large portion of the surface. Carbonic acid gas, occluded oxygen, sodium, calcium and magnesium chlorides are common causes of corrosion. Magnesium and calcium chlorides are very pernicious in that they produce free hydrochloride acid on hydrolysis. Corrosion is also found in boilers using a high percentage of condensate or distilled water.

Where pitting and corrosion occur under deposits of scale, the trouble is usually due either to the presence of free acid in the water or to the liberation of acid by the dissociation of magnesium compounds or other substances.

The corrosive effect of sulphuric acid in the boiler room follows an unending cycle of first dissolving iron and then precipitating it, liberating the acid which again immediately dissolves more metal. As a consequence of this condition a small amount of sulphuric acid within the boiler keeps up a constant attack on the metal and this corrosive action may occur with a boiler feed water in which no free acid is present when delivered to the boiler.

Pitting and corrosion, when found in equal intensity both above and below the water line, may be attributed to the presence of hydrochloric acid which is volatile at boiler temperatures. While hydrochloric acid is not found in feed water it may be formed in the boiler from the decomposition of the chlorides of calcium or magnesium.

Dissolved oxygen may cause pitting and corrosion at or above the water line. It is more apt to be found in boilers which are operated intermittently, than in boilers which are under a constant load.

Sources of Water Supply

Boiler feed water is obtained from any one of four principal sources, as follows:

1—Condensate
2—Bays or lakes of fresh water.
3—Flowing streams
4—Wells

There is a fifth source of supply, city water, which, while it originates in one of the four sources listed above, demands separate consideration because of the treatment this water undergoes to fit it for public use.

Condensate—Condensate is certainly the ideal form of feed, a fact nowhere better evidenced than in the design of our modern central stations. Every effort should be made in all plants without exception to see that not a pound of exhaust steam from auxiliaries, pumps, stoker engines, traps, etc., is allowed to go to waste.

Lakes and Bays—Lake water has the merit of uniformity, and when a practical method of purification has once been developed, a standard of practice can be set up and maintained year after year. Lake water is almost invariably alkaline seldom badly bi-carbonate, and in general presents no serious problem.

Flowing Streams—With rivers we have an individual problem as one stream is acid and the next alkaline. Moreover, the number of parts of impurities to the gallon varies not only from season to season, but daily and hourly. There is one redeeming feature, however, in that this variation in the quantity of impurities does not extend to the ratio of the impurities one with another. This means that in dealing with river water, we can count on the same relative percentages of impurities one with another at all times, and this greatly simplifies our problem.

Wells—Wells are seldom used for boiler feed when other sources are available. Generally speaking they contain a concentration of impurities, and while the water is almost uniform in its analysis, still the quantities of impurities to be disposed of are so great that adequate treatment is a real problem.

City Water—City supply, while pure enough for drinking purposes, is usually a dangerous proposition for boiler feed. It is very apt to contain chlorine, which presents a serious problem in itself. If it has been filtered, the organic matter has largely been removed, but the scale forming salts remain.

Specification for Ideal Water Purification Plant

The ideal boiler purification plant should measure up to the following specifications:

1—It should produce a water with which can be maintained an internal boiler condition of predetermined alkalinity, without by-carbonate, without scale formation, without corrosion and without foaming.

2—There should be no deposits in the feed lines and pumps and no undue wear on valves and moving parts.

3—There should be no bad effects from steam to prime movers, packing or lubrication, or to the product, if steam is used for industrial purposes.

4—It should involve a minimum of expert attention and should require only simple standard chemical elements, using standard reagents and standard indicators.

5—Fitters should not be required.

6—Its capacity should be unlimited and the cost low.

Overhauling and Adjusting in the Engine Room

This Article Describes the Valve Motion of the Marsh Pump—The Operation of the Valve—The Self-Governing Action—The Cushioning Valves—Maintenance and Repair

By "FITTER"

CONTINUING our articles on the various types of simplex pump valve, we come to that of the American Marsh pump made by the American Steam Pump Company, of Battle Creek, Mich. This is a somewhat more complicated type of valve than those shown so far. However, with the help of the cut, it can be made quite clear, and its ingenious design fully understood.

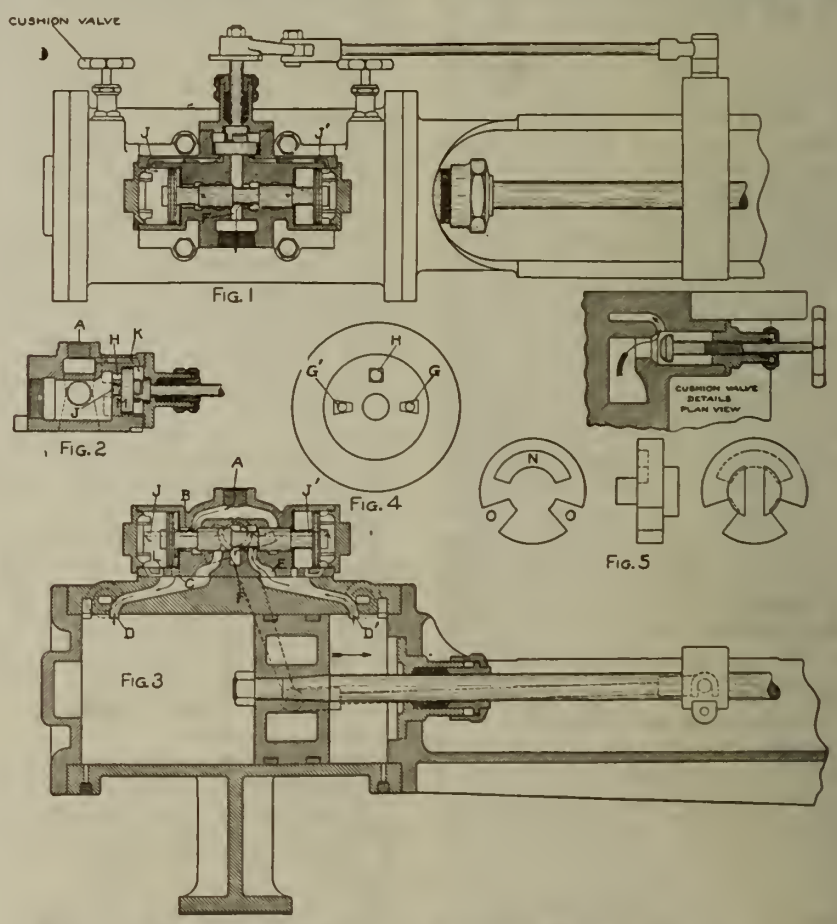
Looking at the cut, the lower view Fig. 3 shows a sectional elevation of the cylinder and steam chest, showing the main valve and steam ports. In the top view Fig. 1, is shown a plan view of the main and auxiliary valve, and the lever which operates the auxiliary valve from the pump rod crosshead is shown. The two valves one at either end of the cylinder, which are used for cushioning are also seen on this view. The intermediate views show details of the auxiliary valve and valve seat, and the cushion valve and its ports.

The Operation of the Valve

In the view shown in Fig. 3, the steam piston is on the outward or forward stroke, and steam is being admitted to the steam chest through the pipe A, through the throat passage B, and the passages C and D. On the exhaust side of the piston, the steam is passing out through the ports D, E and F to the exhaust cavity. The openings to these passages are controlled by the position of the steam valve and this is in turn controlled by the auxiliary valve. The separate halftone of the valve will show the arrangements of the ports more clearly than the small general view. Referring to Fig. 1 again, which is a plan view of the steam chest and auxiliary and main valves, the ports commencing to the main valve from the auxiliary can be seen marked J and J'. The valve lever is shown connected at the back of the auxiliary valve, where it fits into the slot shown in the right hand view of Fig. 5. Figure 4 is a view of the auxiliary valve seat, and it will be seen that the ports G and G' are in direct communication with the ports J and J'. The auxiliary valve front, back, and side views are shown in Fig. 5, and it will be seen by the front view that there are three ports in the valve. The two ports O and O correspond to the ports G and G', while the port N is made long enough to cover the ports G and H in one direction or G' and H' in the other. The action of the valve lever is to oscillate the auxiliary valve, alternately admitting steam to the back of the main valve through the port J and J' and exhausting it through the same ports. When the auxiliary valve is turned by the valve lever so that the port O covers the port G', then the port N will be covering the ports G and H, thus allowing the steam at that end of the chest to exhaust through the port J to F. The result will of course be to move the main valve over to the other side of the steam chest, reversing the movement of the piston. The auxiliary valve chamber is supplied with steam through the port K in Fig 2, and the pressure tends to keep the valve up to its seat.

Self Governing Action

It will be noticed that the area of the inner side of the main valve heads is smaller than the outside by the amount of the area of the body of the valve. This difference of area is used as a means to govern the motion of the piston. In the position of the valve in Fig. 3, the inside of the head is in communication with the entering steam through the passage B, and this would tend to move the valve over to the left, thus closing the port B to steam. To counteract this, steam is admitted from the cylinder to the back of the main valve, acting on the greater area, though with reduced pressure. This overcomes the tendency of the higher pressure steam on the lesser area, and the valve is thus kept in perfect balance. Suppose now the pump should lose its water, and tend to run away violently as pumps do. Having no resistance on the water end, the steam piston would advance very rapidly. This would of course reduce the steam pressure in the cylinder and therefore on the back of the main valve, while the admission pressure on the inner head would remain the same. The result would be that the high pressure steam on the small area would overcome the resistance of the lower pressure steam on the larger area, and the valve would move to the left, thus closing the port B and shutting off the steam. On the other hand, when the pump has a full head of water to pump against, the pressure on the piston approximates closer to that of the admission steam, and tends to move the main valve to the right and thus give a larger opening to port B. The same applies of course to both ends of the cylinder. This is a highly ingenious valve, very well designed.



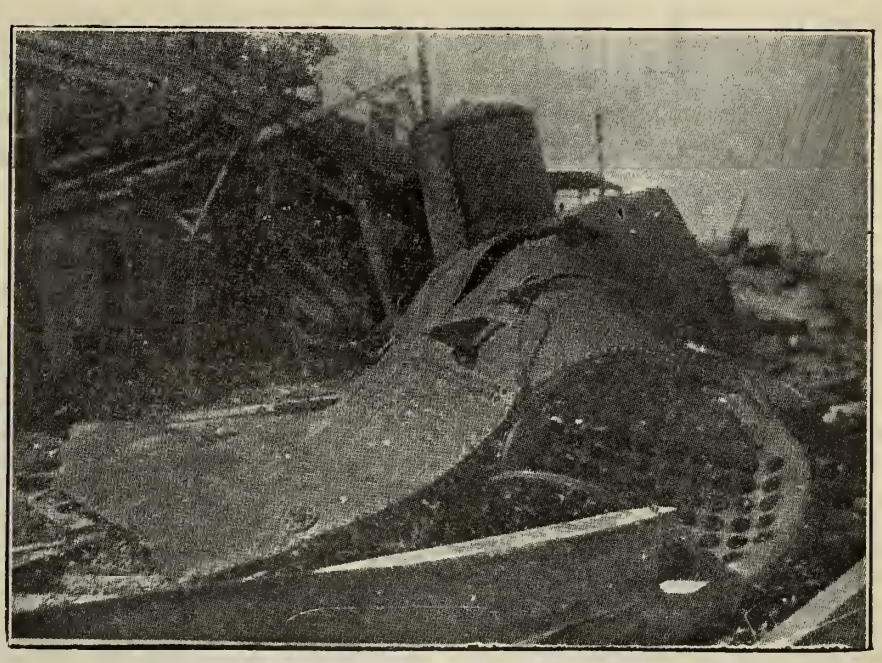
Details of Main and Auxiliary Valves

The Cushioning Valves

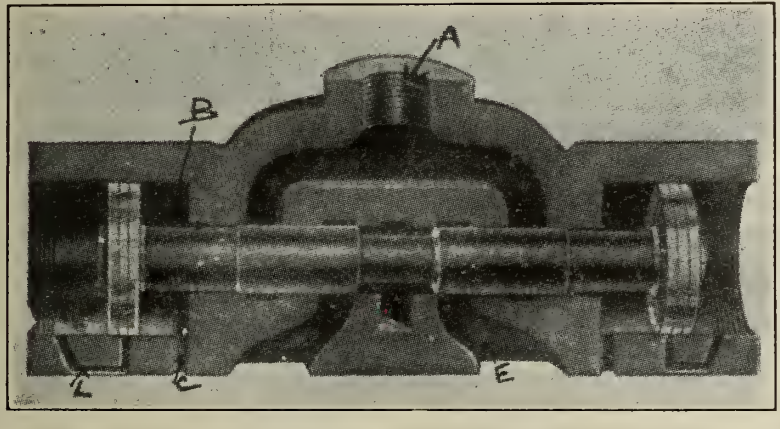
The plan view of the details of the cushion valve will explain its action without much help from the text. The small

port at the extreme end of the cylinder communicates with the main exhaust part, the cushioning valve being placed between them as shown. If the cushion valve is quite shut, then the steam in the cylinder will be trapped as soon as the piston covers the port D', and compression will start immediately. If the cushioning valve is left wide open then of course there will be no compression, and the piston will strike the cylinder end. The way to set these valves as recommended by the makers is to leave them open allowing the piston to strike the ends of the cylinder lightly, and then adjust them till quiet working is secured.

This valve also has the advantage of but few working parts, these being confined to the auxiliary and main valves inside the steam chest, and the auxiliary valve spindle with its lever and two swinging joints outside. The maintenance of this resolves itself into a matter of bushings and pins for the lever joints, while the auxiliary valve being of the



A VIEW OF THE RUINS.



ARRANGEMENT OF MAIN VALVE.

disc pattern, should wear to a perfect face all the time. The wear on the main valve, with ordinary care and lubrication, should be very slight, and its life indefinite. In case of necessity of replacement, it is a simple job, and when a machine shop is on the premises it would be very easy to take the valve chest and bore it turning up a spindle to fit. Of course, if within reasonable reach of the makers, spare parts could be secured in a short time, but allowing for the fact that this is not always possible, the above applies.

THE BOILER AFTER THE EXPLOSION

FATAL BOILER ACCIDENT

The accompanying illustrations show the damage effected by the explosion of a horizontal return tube boiler in the mill of the McKeithan Lumber Company, South Carolina, in April last.

The mill had been idle for some time and was about to resume operations, the boiler plant having been fired up for this purpose. About two hundred men were about to report for work, but shortly before they arrived, the boiler exploded with terrific violence. If the accident had occurred a little later the casualty list would have been much larger, but as it was, two men were killed. The mill itself was almost entirely destroyed, the damage being estimated at $30,000. The accident was reported and illustrated in the pages of the "Locomotive" to whom we are indebted for this account.

The boiler was built with two sheets, one upper and one lower, with two horizontal lap seams running the full length of the boiler. The explosion as is usual in this type of construction, was a result of a lap seam crack. Whereas a boiler subject to this type of defect is always treacherous, the long seam gives additional opportunity for an extremely violent explosion because the boiler may rip open from head to head. This is clearly shown in the illustration, and evidence of the fatal lap seam crack can also be seen.

The Lubrication of Air Compressors

Lubrication in General—Nature of Friction—Mineral Oils in General —Density, Viscosity, Flash Point—Physical Properties of Oils for Lubricating Air Compressors

By A. D. RISTEEN

THERE are many opinions on the subject of air-compressor lubrication. Only the internal lubrication of the air-compressor will be considered, and perhaps it may be well to begin by giving a little thought to lubrication in general.

Lubrication in General

Let us go back to fundamentals, and ask why we lubricate machinery.

In the first place, we desire to reduce friction. Needless friction involves the expenditure of a corresponding needless and therefore wasteful amount of mechanical energy. Furthermore, friction causes the rubbing parts to wear away, and that means overhauling and repairs. Finally, heat is developed where the friction occurs, and this is specially objectionable in an air compressor or any other mechanism that must be artificially cooled in any event, on account of the generation of heat from causes other than friction. We certainly do not want to develop avoidable additional heat in any place where we have to take special measures to remove the heat that is necessarily generated there.

Another reason why we need lubrication in the cylinder of a steam engine or an air compressor is, that it is important to seal the space around the piston, in order to prevent leakage under the piston rings or between them and the walls of the cylinder.

Nature of Friction.

We are told that friction is due to the interlocking of the little irregularities on the surfaces that are sliding or rubbing upon each other. Beyond all question there is considerable truth in this theory, but it certainly does not tell the whole story. When dealing with surfaces that are appreciably rough, we may be sure that there is a certain amount of interlocking of the projections, comparable in a small way with the interlocking that occurs between the teeth of a pair of gears. To reduce this interlocking, and the consequent resistance to motion, we make our sliding surfaces reasonably smooth,—reducing the projections until they are no longer of any practical importance; but even when the bearing surfaces appear to be absolutely smooth, we have not wholly eliminated friction—nor, after passing a certain stage, have we even reduced it in evident proportion to the increasing smoothness. A smooth bearing that is run without lubrication is likely to stick or "freeze," and although this action is attended by the development of heat, the temperature at which it occurs is usually far below the welding point.

We usually think of a lubricated shaft as floating on or in a film of oil, which is drawn inte the space between the shaft and its bearing partly by the rotation of the shaft and partly by capillary attraction. This conception doubtless corresponds with the facts in large measure, yet it cannot be altogether correct, because if it were the friction would be wholly fluid friction, and it would be practically independent of the nature of the lubricated surfaces.

The fact that flotation is not the whole story may be shown by a simple experiment described by W. B. Hardy ("Nature, December 30, 1920, page 569). To perform it we need a smooth, clean sheet of plate glass, and a glass weight with a similarly smooth, clean surface. The sheet of glass is placed in an inclined position, with the weight resting upon it near the upper end. By increasing the steepness of inclination of the plate, we presently reach an angle at which the weight will just slide down the plate freely. If we now wet the lower half of the plate and let the weight slide down as before, we find that it stops as soon as it comes to the wet part. Let us now repeat the experiment, using a glass weight as before, but substituting a polished sheet of ebonite for the plate of glass. If the steepness of the ebonite surface is adjusted so that the glass weight will not quite slide but is on the verge of doing so, we shall find that it slides down quite freely when the ebonite surface is wet with water. The water increases the friction in one case, therefore, and lessens it in the other; and this shows that the friction problem is quite complicated, if we try to go into it at all deeply, even when we confine our attention to the most elementary phases of it, and do not take account of such things as the deterioration of the lubricant through use, or the means by which it is to be effectively applied to the surfaces.

Mineral Oils in General

In specifying an oil for lubrication purposes, it is customary to indicate the chemical nature of the oil in a general way, and to specify (1) its density, (2) its flash point, and (3) its vicosity.

It is universally agreed, I am sure, that the oil used for lubricating air-compressor cylinders should be purely mineral, and we shall therefore take that much for granted.

Oils of this nature may be divided into two general classes which are known, respectively, as paraffin-base oils and asphaltic-base oils. The paraffin-base oils occur notably in the Pennsylvania region and the Appalachians, and the asphaltic-base oils are specially associated with the extreme south and west. The mid-continent oils may belong to either system, and some of them are mixtures of the two. Crude paraffin-base oils, upon distillation, leave solid residues consisting of hydrocarbors of the paraffin series; and the asphaltic-base oils, upon distillation, leave solid residues of an asphaltic or bituminous nature. I believe, however, that either group can furnish oils well adapted to thepurpose we have in mind.

Density.

The density of an oil is usually specified on the scale devised by Antoine Baumé—a French chemist who was born in 1728 and died in 1804. In accordance with his plan the density of a liquid is determined by immersing in it a float having a projecting stem which is graduated in accordance with a certain arbitrary plan. Two different methods of graduation are used, according as the liquid to be tested is lighter or heavier than water. In establishing his scale for oils and other liquids lighter than water, Baumé immersed the float in a solution containing 10 parts of common salt to 90 of water, and the point at which the liquid then stood, on the stem, was defined to be "zero." The instrument was then placed in distilled water, and the point on the stem that was level with the surface of the water was marked and defined to be "10 degrees." Between these marks the stem was divided into 10 equal spaces or "degrees," and the rest of the stem was graduated in degrees of this same length. It would be much better and simpler to state the specific gravity of the oil, rather than to use such an arbitrary scale; but inasmuch as the Baumé hydrometer is in general use by oil men, we shall have to abide by it for the present. Tables are given in many works of reference, to enable us to translate Baumé readings into specific gravities, or the converse.

Viscosity

Viscosity is the quality that makes molasses run slowly in January. In oiling watches and other fine machinery, the viscosity of the lubricant must be very low; but in dealing with heavy machinery it is necessary to use an oil with a considerable amount of viscosity so that the pressure to which the oil is subjected will not force it out of the bearings, nor wipe it off of the surface that is to be lubricated. For each particular lubrication problem, in fact, the viscosity should lie within certain appropriate limits, which will vary according to the nature of the conditions to be

*An address delivered by A. D. Risteen of The Travelers Insurance Co., before the Engineering Section of the National Council in Philadelphia.

met, and which must be ascertained by experience.

The viscosity of an oil falls off with increasing temperature, and often to a great extent. In choosing an oil for use in a hot place like the interior of the cylinder of a steam engine, or a gasoline engine, or an air compressor, we should therefore be sure that the oil we select will have a suitable viscosity at the temperature at which it is to be used; and this may mean that it is exceedingly thick at the ordinary room temperature.

In the United States, the viscosity of oils is determined mainly by means of an instrument devised for this purpose by G. M. Saybolt; though the United States Government has in the past made considerable use of a similar instrument designed by Englar, and extensively employed in Continental Europe. The main objection to the Saybolt apparatus has been, that until recently its construction and mode of use have not been sufficiently standardized. This has recently been remedied, in large measure, by the American Society for Testing Materials ("Proceedings," Vol. 19, 1919, Part I., p. 728) and the United States Bureau of Staudards ("Technologic Paper No. 112," 1919); and it is likely that the Saybolt universal viscosimeter will be the standard instrument in this country, hereafter, for the practical determination of oil viscosity. In using it, sixty cubic centimeters of the oil to be tested are allowed to flow into a receiver from a glass tube of specified shape and dimensions, and the number of seconds that are required is taken as the measure of the viscosity. Thus when we say that an oil has a viscosity of "140 S." (the S. standing for "Saybolt"), we mean that sixty cubic centimeters of the oil will flow out of the standard tube in 140 seconds. The measures so obtained are only relative, it is true, but they give a good means of comparing oils with one another, and that is all that is needed for most of the practical applications that we hace to make, in the arts. v

Flash Point

The flash point of an oil is the lowest temperature at which the oil gives off a vapor than can be ignited by means of a flame or an electric spark. The temperature at which actual ignition occurs without the application of flame or an electric spark is a totally different thing, and is called the "fire test" or "ignition point." It is important to remember this distinction in discussing air-compressor explosions; yet we often hear the "flash point" erroneously referred to as though it were the temperature at which an oil will burst into flame spontaneously. In the United States, flash points are determined by means of the so-called "open-cup" apparatus, in which the oil under examinatio nis gradually heated until the vapor from it can be ignited by a flame or spark—the temperature at which this first becomes possible being noted by a thermometer, and recorded as the flash point. To obtain uniform and consistent results in this work, skill and experience are required.

Physical Properties of Oils for Lubricating Air Compressors.

In lubricating the cylinder of an air compressor, we must use an oil that is viscous enough to resist the tendency of the piston to wipe it off and leave the metal surface dry; but the viscosity should not be great enough to offer any considerable opposition to the motion f the piston. We must remember, in other words, that lubrication is intended to diminish friction, as well as to seal the piston so that air cannot leak around it. The errors that are made in selecting oils for lubricating air-compressor cylinders pobably tend toward a viscosity that is too high instead of too low. The average viscosity corresponding with good practice ranges from 230 to 315 seconds on the Saybolt scale for paraffin-base oils, and from 275 to 325 for asphaltic-base oils. The minimum limits for viscosity in good practice are given as 120 S. for paraffin-base oils and 175 S. for asphaltic-base oils.

The average density for good practice is given as 25° to 30° Baumé for paraffin-base oils, with a minimum of 32° and a maximum of 25°; and as 19.8° to 21° Baumé for asphaltic-base oils, with a minimum of 22° and a maximum of 19.5°. (Higher readings correspond, of course, to lighter oils.)

In connection with the flash-point tests (as made by the open-cup apparatus), 400° to 425° Fahr. are recommended as good average practice for paraffin-base oils, and 315° to 335° Fahr. for asphaltic-base oils—the fire test being higher than the flash point by about 50° in the paraffin-base oils, and by from 55° to 65° in the asphaltic-base oils.

Explosions of External Origin

In considering the relation of lubrication to air-compressor explosions, we may note that these accidents are sometimes due to causes external to the air end of the machine. As an example of an explosion initiated by an external cause, yet having a certain bearing upon the lubrication problem, I may cite a case in which the steam pipe running to the compressor failed, doing considerable damage in a small way to the machine, and incidentally causing the rupture of the air pipe and liberating the contents of the receiver. Shortly after this occurred there was a violent secondary explosion, which blew out the whole side of the building. It is believed that there was considerable oil in the bottom of the receiver, and that the escaping air blew this oil out into the room in the form of a fine spray. A battery of boilers was located in the same room, and we may reasonably suppose that the spray took fire at one of the furnaces. A gallon or two of oil disseminated through the air in the form of mist could easily give rise to a violent explosion, when brought in contact with flame or with a bed of white-hot coals.

It is bad practice to allow considerable quantities of oil to accumulate in a receiver tank, or in any other part of the air system. Every receiver tank should be provided with a drain pipe having a diameter of at least half an inch, and preferably three-quarters of an inch; and these drains should be opened frequently and regularly, to remove any oil or water that may collect in the receivers. Appropriate means should also be provided for draining other parts where oil may accumulate.

We are mainly interested, on this occasion, however, in accidents consisting in the explosion of something inside the compressor or its piping or other connections, or which are initiated by such internal explosions; and in considering these we naturally ask ourselves, to begin with, what there is inside of the compressor or its connections that can explode.

The Oil-Vapor Theory of Explosions

A good many persons who have speculated on air-compressor explosions from internal causes have attributed them to the ignition of oil vapor. The air in the compressor cylinder has a rather high temperature during a part of each cycle, in consequence of the heat developed by the compression. In an ordinary air compressor with tight valves, the theoretical limit of temperature might be somewhere about 600° or 700° Fahr., if the compression took place adiabatically —that is, without any loss of heat. In the actual machine, however, there is a considerable cooling action largely on account of the water jackets; and when the compression is effected in two or more stages, there is further cooling in the intercolors that are(or should be) provided between each cylinder and the one next following. Taking these things into account, the maximum temperature occurring in any given cylinder should not exceed something like 400° Fahr. It would be useless to make a more definite estimate than this, because the figure will naturally vary with different machines.

It has been maintained that lubricating oil is likely to give off an inflammable vapor at the temperatures indicated; and this vapor, when mixed with the air in the compressor, has been supposed to be capable of exploding and producing the observed effects. Let us examine this theory a little more critically. In the first place, some of its opponents have confidently stated that explosions occur in connection with high flash-point oil even oftener than they do in connection with those having low flash points. If this could be satisfactorily established, it would practically sound the knell of the oil-vapor theory; but as I cannot substantiate the statement, I shall not base any conclusions upon it.

Most of the oil that is present in a compressor cylinder is lodged upon the walls of the cylinder, and owing to the proximity of the water in the cooling jackets, these walls do not have a temperature anywhere near as high as the air in the middle of the cylinder. Under good operating conditions and with well designed apparatus, the inner surface of the cylinder wall is probably not much

more than 50° Fahr. hotter than the maximum temperature of the jacket water. If this is so, it follows that the oil that is adhering to the cylinder is not giving off any significant amount of inflammable vapor, because the greater part of it is adhering to the comparatively cool metal. Some of the oil will be lodged on the face of the piston and this may be not enough to give off a certain amount of inflammable vapor, if the flash point of the oil is lower than the maximum temperature of the air in the cylinder. It is important to note however, that under normal working conditions the air in the cylinder is comparatively cool during the greater part of every cycle—the high temperature being attained only toward the end of the compression stroke. Hence the total evaporation of oil from the faces of the piston will be far smaller than the advocates of the oil vapor theory have probably assumed.

Furthermore, any oil vapor that is present in the cylinder is swept out with the air every time the cylinder discharges into the receiver; and in the normal working of the machine the vapor that is formed per cycle cannot, on the average, exceed that which could be formed from the amount of oil that is admitted per cycle. With proper lubrication this amount will be so small that we cannot conceive it to be capable of doing the least harm. Certainly it could not produce a violent explosion.

Oil spray in the cylinder or connections is sometimes suggested as a thinkable source of explosive action. It is hard to understand how spray could be formed from oil that has once adhered to the metal walls, except in consequence of the rupture of some part of the apparatus as already described; and in connection with the oil that is introduced into the compressor with the inflowing air, and which has not yet attached itself to the metal parts, the arguments already reviewed in connection with oil vapor appear to be conclusive. Namely, any spray of this kind that does not immediately lodge upon the walls is swept out into the receiver with the next discharge from the compressor; and moreover, the amount of oil spray, under any half-way reasonable conditions of operation, would be so small that any explosion that it might produce would not even be noticeable.

Dust and "Carbon"

We come, now, to the consideration of such combustible solid matter as may be present in the cylinder or its connections; and here we are encountering a far more serious item. The free solid matter that is found in the cylinders, piping, and receivers of air compressors is of two general kinds. First, it contains whatever may have been introduced into the air compressor in solid form—for example, dust drawn in through the intake. The dust held in suspension by the air that is taken into the compressor usually contains more or less mineral matter, which is likely to be either sandy or clay-like. Such matter is incombustible, and probably would not be directly harmful except as it may increase the friction and the wear. But the incoming air may also contain combustible material, and this must be reckoned with. The combustible matter may be of an organic nature, or it may consist largely of particles of carbon. This last condition is most likely to prevail when the intake of the compressor is located near a coal pile, or where it can take in more or less smoke from a chimney or stack. To prevent accumulations of this kind, it is highly important to draw in the air from a place as free from dust as possible. It would be wise to filter the air through dust-proof and smoke-proof screens, before allowing it to enter the compressor. This is not always practicable however.

"Carbonization" of the Oil.

The other source of solid matter in the cylinder or receiver or connections is the so-called "carbonization" of the oil itself. We speak of solid deposits of this nature as "carbon"; but although they contain free carbon, they consist largely of oil in various stages of disintegration, and of compounds formed from the oil under the influence of heat and the oxygen of the air. (For a good account of the carbonizing of lubricating oils, covering the nature of the deposit and the theory of its formation, consult Circular No. 99 of the Bureau of Standards, 1920.) Carbonization is due in large measure to the use of improper oil, or of an excessive amount of oil. The oil should have such a composition that it is reasonably stable, at the temperatures that are likely to occur in the compressor or its connections; and this means, among other things, that it should not contain any animal or vegetable constituents, but should be purely mineral. Any oil will undergo a certain amount of decomposition, however, under the conditins to which it is exposed in air-compression apparatus. Slow oxidation is favored by the fact that the oil is spread out in a thin layer and exposed to heated air. Moreover, at the temperatures that prevail in the apparatus the oil is likely to "crack" to some extent. That is, it is likely to break down, slowly, with the formation of somewhat lighter oils, and the simultaneous liberation of a certain amount of free carbon. No oil that is worth even momentary consideration contains, in its original state, any free carbon; and the percentage of carbon present in the oil (in combination with hydrogen) is no criterion whatsoever of the likelihood of the oil to deposit carbon. The carbon deposits thrown down by paraffin-base oils are said to be hard, gritty, and specially adhesive, while those that are derived from asphaltic-base oils are described as fluffy and easily removable. However that may be, it is certain that any oil that gives a considerable deposit of so-called carbon is objectionable in connection with air-compressor lubrication, whatever the nature of the deposit may be. For example, the "carbon" may interfere with the valves of the compressor, and prevent them from closing properly.

Now, as to the amount of oil that should be used. As a rule, air compressors are over-lubricated. The walls of compressor cylinders are dry, and oil sticks to them far better than it does to the cylinder of a steam engine. Therefore, it is not necessary to use anything like so much oil in the air compressor. Roughly speaking, the amount used in a compressor cylinder should never exceed one-quarter the amount that would be used in a steam cylinder of equal size, and a smaller quantity than this is usually preferable. Some authorities state that it is advisable to use only one-tenth the quantity that would be required in a steam cylinder of like capacity. It is not practicable to make a hard-and-fast rule covering this point, because it is necessary to allow considerable latitude on account of variations in the oil, and in the working conditions. The best plan is, to remove a valve from time to time, and examine the condition of the cylinder surface. If it is covered with a thin film of oil, the lubrication is at all events sufficient; but if it is dry, more oil should be supplied. The quantity of oil used should be as small as is consistent with the maintenance of the oil film.

Care of the Cooling Jackets

In conclusion, I wish to make one suggestion which, although it is not directly connected with lubrication, is nevertheless quite important and may have a good deal to do with the safety of the machine. I refer to the proper care of the cooling jackets. If the water that is circulated through these jackets contains much scale-forming matter, a solid stony coating is likely to form, in the course of time, on the cylinder-wall of the jacket, and this will naturally diminish the cooling effect of the jacket, and allow the cylinder wall to become needlessly hot. Heavy accumulations of a muddy or sandy nature are also likely to form in the water jackets, when the water contains considerable quantities of sediment, and in a bad case of this kind the jacket-space may be entirely filled up, except for a small channel extending through the deposit from inlet to outlet. Of course a jacket that is in this condition is useless as a cooling device.

The jackets should be watched for evidence of deposits of sediment or scale, and whenever anything of this kind is found, it should be removed by appropriate means. It may be possible to wash out the mud by using a strong stream of water,—stirring up the deposit, if necessary, by means of a flexible rod or something of that nature. When a stony deposit of scale is found, it should be removed by filling the jacket with a hot solution of caustic soda or some other suitable substance; and if there is much trouble of this kind the water should be purified before admitting it to the jacket, or the source of supply should be changed. Where trouble is experienced from sediment, the water should either be filtered before use, or be allowed to stand in large settling tanks until it has become clear.

In any event the supply of water

should be abundant, and the man in charge should know, with the utmost positiveness, that there is a free flow through each jacket. The best way to make sure of this is by having the discharge from the jacket visible, and locating in a conspicuous place, so that any significant lessening in the quantity of escaping water will be noticed at once. This precaution is a wise one, in fact, in connection with any apparatus in which a circulation of cooling water is important.

Ignition of the Carbon.

It is well known that these carbon deposits take fire, at times, when the conditions are favorable; and this can hardly be due to the air in the compressor attaining a temperature high enough to ignite pure carbon, especially when the carbon is in compact form. Bearing in mind the fact that the deposits seldom or never consist of pure carbon, but contain considerable quantities of decomposed oil and other substances, we can get a glimpse of certain interesting chemical possibilities which I will briefly outline.

It is not unlikely that the free carbon that is present in the deposits occasionally acts as a catalyzer, in promoting the rapid oxidation of the oily matter with which it is associated. Catalysis plays an important part in modern chemical manufacturing, and we are enabled, by means of it, to bring about many chemical reactions that will not occur unless a suitable catalytic agent is present. Charcoal and coke are among the substances used, in this way, to promote certain chemical actions; and perhaps it is not unreasonable to assume that the carbon in a compressor or its connections may sometimes induce rapid oxidation of the oily matter. It is known too, that some of the products that would be formed in this way are themselves capable of acting as catalyzers, so that they might accelerate the action when it had once become well started. Fine metallic particles, worn off from the cylinder or the piston, are sometimes present in the deposits; and iron oxide often occurs to a significant extent—both being active catalyzers under certain conditions.

The heat generated by the beginnings of the oxidation would facilitate further action, and so the thing would go on, until presently we might have a glowing or burning mass. This in itself might precipitate an explosion, by heating the metal walls so that they could no longer withstand the normal air pressure to which they are subject. Furthermore, the carbon deposit, if it happens to be of a light and fluffy nature, may be disturbed so that we have what is in effect a dust explosion, the finely divided carbon playing the part of the dust and the ignition taking place in consequence of the catalytic firing of the oily matter in the way I have described; and even if the carbon deposit were originally compact and hard, it might take on a loose, sooty character as soon as the oily matter combined with it had burned away. Somebody has calculated the amount of carbon dust that would be required to give an explosion comparable in violence with those that have been recorded, and he finds that if the carbon that is ignited in the form of dust were sufficient in amount to fill half a cubic inch when compressed into compact form, we should have enough explosive material to explain any accident of this type that might be cited. I would not like to say, however, that it is the carbon only that explodes. What happens after the trouble has started, is more than I can guess.

Hard carbon deposits often prevent the valves of a compressor from closing properly, and this is likely to cause serious overheating. The piston, in making its return stroke to fill the cylinder with a fresh charge of air, will be followed by a certain amount of the compressed and therefore heated air, flowing back through the leaky valves from the receiver and its connections. Under these circumstances, the contents of the cylinder are already, and before the compression begins, at a temperature considerably higher than that of the surrounding atmosphere; and this means that when the next compression stroke is completed, the temperature in the cylinder may be a good deal higher than it would be if the valves were tight. The increase in temperature produced in this way, and also by the friction of the air in churning back and forth through the restricted valve opening, naturally accelerates any tendency toward the production of fire and is, therefore, a serious matter.

Removal of Carbon and Oil Deposits.

Every effort should be made to prevent the accumulation of "carbon" deposits anywhere about the compression apparatus, and such matter as may be deposited in spite of all reasonable precautions in the way of selecting the oil and feeding it to the cylinder should be cleaned away, frequently and regularly. A good deal can be accomplished in the way of cleaning the compression apparatus by discontinuing the oil from time to time and feeding soapy water into the cylinder for two or three hours—say once a week. This often helps marvelously to clean out carbon deposits and deposits of gummy oil. The soap solution may be made up of one pound of soft soap to seven or eight quarts of water, and it is advisable to feed it into the cylinders at a rate something like ten times as great as the rate at which the oil is ordinarily supplied. The frequency with which this treatment should be given depends upon the experience that has been had with the particular air compressor under consideration. Some authorities recommend the introduction of a solution of lye into the pipe between the cylinder and the receiver, every month or two. The lye solution may be made up by using one pound of lye to eight or ten quarts of water, and it may be delivered into the air discharge pipe by means of a sight-feed lubricator at the rate of 60 to 70 drops per minute. After using the lye or the soap solution, the receiver should be blown off, and oil should again be used in the cylinder for a time, before stopping the compressor. Otherwise rusting is likely to occur.

When hard carbon deposits form, which are not removable by the treatment here suggested, they should be cleaned out by whatever means may suggest itself as most effective. For instance, the air valves should be removed whenever necessary and cleaned by mechanical means. No kerosene or other inflammable solvent should be introduced with the air, however. This practice, which is far from unknown, is exceedingly dangerous.

The Link Belt Company of Chicago have recently published a new book on Belt conveyors, known as book No. 215, dealing with Uniroll and Multiroll idlers recommended by the company for their equipment. The book also contains useful information in the shape of correct methods of figuring on belt conveyors and their capacity. Price lists are included which make it possible for the customer to figure up the whole cost of a proposed installation, or any portion of it. There are also suggestions as to the right type of equipment for different purposes, and a number of illustrations of typical installations are included.

The Canadian Link Belt Co., of Toronto and Montreal have issued a new steel data book No. 475. In this book is presented the heavier rugged steel chains used for Power Transmission, and it also includes elevating and conveying chains.

VISITORS, DELEGATES AND EXHIBITORS AT OTTAWA CONVENTION C. A. S. E.

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POWER HOUSE

AUG, 5th, 1921

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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The U.C.C. Convention

THE Convention of the Universal Craftsmen just concluded at Toronto has been a notable event. A full report will be published in the next issue of the Power House, but in the meantime we feel that there are some things to be said about it that cannot wait.

The convention was the first that the Universal Craftsmen's Council of Engineers has ever held in Canada, though judging by the feeling of the delegates it will be by no means the last. It was the means of bringing to the city of Toronto upwards of two hundred operating engineers from all parts of the United States. These men, all of them occupying positions of responsibility and trust, and therefore with a certain influence in their respective communities, were practically all visiting Canada for the first time. Many of them before coming had some of the peculiar ideas of Canada and British Institutions that prevail in the inland cities of the United States. They came to Toronto, met engineers who could talk to them on as high a plane professionally as their own, saw an exhibit of engineering appliances that would be hard to equal in any exhibition they have ever attended, and were given excellent opportunities to see the business and social side of an essentially Canadian and British city.

It is a good thing for stationary engineering, and for Canadian stationary engineers in general, whether members of the craft or not, that a society so strongly representative should choose a Canadian city for their convention. A lot of people who had but a vague idea of what stationary engineers were have seen the well dressed and prosperous looking delegates attending the King Edward this week and have received a new conception of the importance of the stationary engineers in their daily life. Hundreds of people not directly interested in engineering have been tempted to look in and see the exhibition and have gone away with food for thought.

The local gentlemen who were responsible for the convention are to be congratulated for what they have done, not only for their own craft, but for stationary engineers and for the City of Toronto. With an example like this in front of them, we should like to see the old society, the C.A.S.E. many of whose members are also members of the U.C.C. spurred to greater efforts, for their own good and the general good of all engineers.

A Vision Worth While

THE WORLD is used to turning to the United States for stupendous undertakings, and not in vain, for while they do not always get the best, yet they usually have the biggest of everything. In another part of this issue will be found an account of the mammoth bridge which is being erected across the River Hudson, to form a great artery of commerce between the states of New York and New Jersey. The bridge like other bridges over the Hudson and East Rivers will be of the suspended type. It would no doubt interest greatly some of the ancient bridge builders of the far east, who in the dawn of the world swung their gossamer like structures on fibre cables over the gorges of the Himalayas, for they would see a structure, surpassing in dimensions anything that their wildest vision could have conjured up, and yet based on the principle that they themselves had used.

We say surpassing anything their vision could conjure, but it is by virtue of that very vision that all these modern wonders have been made a possibility. The bridge builder, challenged by the necessity of the times, and aided by the scientist who with infinite patience pursued the jealously guarded secrets of nature, saw in his mind's eye something larger than had ever been attempted, and with confidence in his ability and the material he had to work with, proceeded to make his vision a material fact. So from the crazy fibre bridge swinging above the abyss, and capable of supporting but one person at a time, we have come to the bridge that can carry foot passengers, wheeled vehicles, street cars, and railway trains with perfect safety. Each great bridge as it has been projected, has been a source of wonder to its generation. The Tay Bridge, the Forth Bridge, the first Brooklyn Bridge, and latterly the Quebec Bridge with its tragic history, have all caused those of little faith and less vision to remark "It can't be done."

Science , the handmaiden of industry, goes quietly on with her appointed task, and makes available better and better materials, which give added strength with less weight, and make it possible for the builder to plan bigger and bigger things . It is all a matter of vision. The scientist, who projects his mind into the abstract; the engineer who takes the result of the scientist's researches and applies them to practical use, and the capitalist, who from his faith in the engineer and scientist, gathers together the gold to make these visions possible, knowing well that though he stands for great reward, he may well stand to lose all. So science, industry, and capital go forward hand in hand, linking up town and country, state and nation till the day will come when all the world will be joined up with such arteries that the farthest points apart will be reckoned not in weeks, or days, but in hours.

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Progress in New Equipment

Steel Belting As a Means of Transmission

Material Used on Such Belts Is a Carefully Hardened Charcoal Steel—Process of Preparation a Secret—Claims Made for This Belting—Safeguards—Stories of Installations

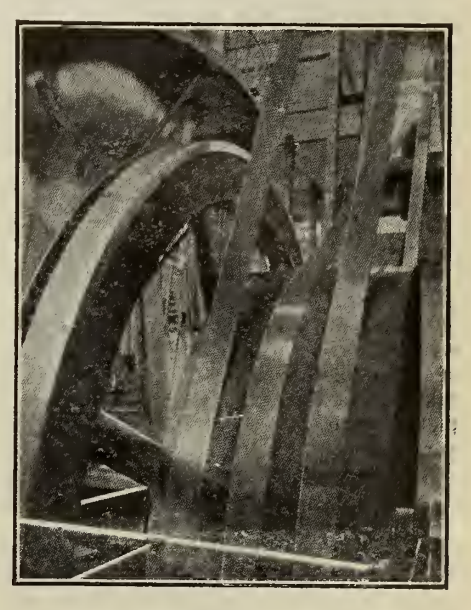
THE LOSS in power in transmission from the engine, whether steam or electrical, to the point of application is a difficulty which has always exercised the minds of engineers wherever mechanical power is used. Experimental attempts were made in employing driving belts of metal, but, after a short period of use they invariably broke when subjected to any considerable increase in load. Persistent failure also attached itself to the various connections used in joining the ends of the bands together. Subsequent experiments showed that these unsatisfactory results were attributable mainly to mistaken conceptions as to the conditions under which steel bands should be used. In previous experiments it was found that consideration was not given to the fact that the metal belt employed is subjected to a flexure constantly varying from zero to a maximum, and that to ensure durability with such a demand it was not sufficient for the belts to be calculated in the usual manner. The error consisted in not regarding the result of philosophical researches first undertaken by Wohler, according to which a tension constantly varying from zero value to a maximum and frequently applied to a body causes self destruction if the maximum tension is not confined to half the breaking stress of the material.

The present system is therefore based on the knowledge that a fracture of the belt even with a constantly varying demand on its flexibility can be avoided with certainty if the maximum demand likely to occur is kept so low that it does not attain half the value of the limit of fracture. Exhaustive series of trials have been carried out in England. According to the present method the breaking of belts is avoided, and the durability made unlimited by the thickness.

It was found that owing to the high modulus of elasticity of steel that it was very necessary to determine the length of a driving belt with considerable accuracy; a short extension compelled by cutting the belt too short in the first instance set up very serious stresses. To accomplish this purpose an ingenious device has been invented for determining the necessary length for the purpose of obtaining a truly correct working tension.

In the patented joint clamping plates are shaped to suit the pulley profile, stresses at the joint are distributed evenly over the whole width, and one of the most prolific causes of fracture in the early installations is thus avoided.

The material used is a carefully hardened charcoal steel, prepared by a secret process, rough rolled at a red heat, and then brought to 0.2 to 0.9 mm. thickness and 12 to 200 m.m. in width by cold working. The tensile strength of the finished material is about 95 tons to the square inch. The edges are rounded and finely finished, so enabling the belt to

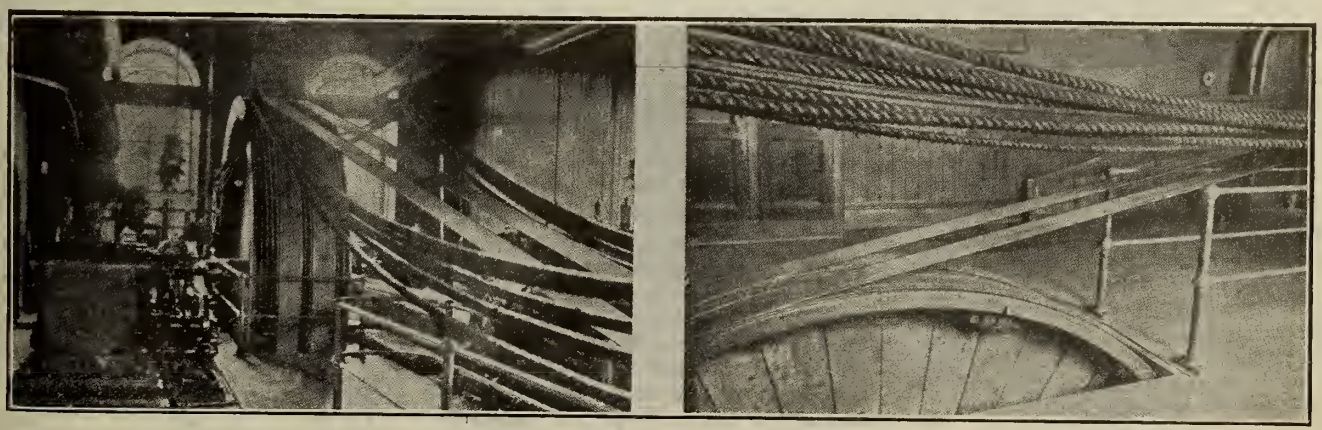


ANOTHER COMPACT STEEL BELT DRIVE.

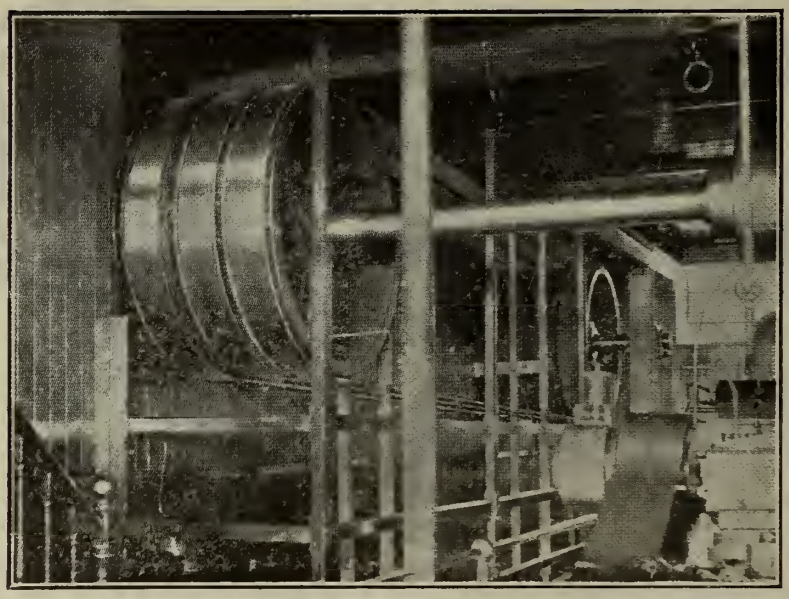
be safely handled even when running at high velocity. The elasticity remains unimpaired with use.

Friction Covering on Pulleys

So that metal does not run to metal



A 450 H.P. DRIVE. SHAFT CENTERS ARE 40 FT. 3 IN. PULLEY DIAMETERS 15 FT. 2 IN., AND 12 FT. 7½ IN. TWO 8 IN. STEEL BELTS REPLACED ELEVEN 1¾ IN. ROPES. THE SPEED RANGES FROM 70 TO 90 R.P.M. THIS DRIVE HAS BEEN IN USE SINCE 1915.



IN THIS CASE THREE 8 IN. STEEL BELTS REPLACED FOURTEEN 1¾ IN. ROPES. THE PULLEYS ARE 5 FT. 6 IN. EACH, AND THE SHAFT CENTERS 20 FT. 8½ IN. THE VELOCITY IS 2,400 FT. PER MINUTE, AND THE H.P. 310. THE BELTS RUN AT 142 R. P. M. THE DRIVE HAS BEEN IN USE SINCE 1915.

and to prevent any possible slip, a friction coating consisting of a layer of canvas, to which is glued fine sheets of cork is placed over the pulley rim, and to avoid stripping under variable load the pulley rim is first serrated by a rough file or chisel nuts. A special cement is available for use in very damp situations.

It is claimed that steel belts have replaced cotton rope drives in a number of cases and that the simplicity of the conversion is such that the conversion of a complete rope race can be undertaken on a Saturday noon and be completed with the steel belts ready for running the following Monday morning. The conversion is said to usually increase the horse power available at the driven shaft by 7 to 25 per cent., this being the result of a number of tests in actual installations. Where space is cramped and drives are running to various floors, steel driving belts are said to be very adaptable.

The requirements necessary to the successful employment of steel belt transmission are simple, but nevertheless important, and given suitable conditions, the results are definite and certain. When it is understood that steel belts must run perfectly true on to the pulleys the tension to remain exactly as when fitted, the conditions demanded will be easily comprehended. The shafts, bearings and fixings must be of a solid construction, strong enough to transmit the maximum load demanded. The shafts must also be parallel, and the pulleys running true and without vibration.

It should be clearly understood that the steel belt is only a part of what actually is a highly scientific system of power transmission. As already explained, the process of preparing the steel and the mounting of the belts is carried out on highly scientific lines.

Safeguards

With ordinary care steel belts are perfectly safe, as in case of fracture the belts will not fly, but fall between the shafts. The edges are rounded and can be handled whilst running. In every country where used they are placed under precisely the same laws and regulations as applied to ropes or leather belts.

Here are a few claims made by the makers of the type of belt we have been describing:

An efficiency in power delivery of 99-99½ per cent. Great steadiness; a necessity for electrical machinery, textile purposes, paper mills, etc. A perpendicular drive is no disadvantage for steel belt driving.

Absence of stretching — a steel belt does not stretch by use, as has been seen by eight years' experience. Even running, free from slip. As there is no actual measurable slip, it follows that transmission by steel belts is uniform and invariable.

Great power under present conditions. —In cases where the pulleys are limited in size it is often possible to get an increased power transmitted by the use of steel belts without any re-arrangement.

Cool bearings.—Owing to the exact calculations of the necessary tension for each particular drive, together with the great reduction in the weight of steel belt. Cleanliness.—No messy dressings are required.

Unwearability. — Steel driving belts have now been in operation for eight years, and tests made of the belts first fitted show no signs of deterioration whatever. It seems evident therefore that the life of the steel belt is unlimited.

Breakages

Where the conditions are in accordance with the requirements, it is only in very isolated instances in which a fracture occurs. These instances are invariably due to a flaw in the material itself, and will show within the first eight weeks of running; by this is meant that if a steel belt runs for eight weeks it is a practical certainty that it is free from flaw and will run indefinitely. To cover any serious stoppage caused by a faulty belt, the manufacturers will, if requested, supply with every drive a duplicate or reserve belt, measured and ready for immediate fitting.

Steel belts vary in width from 2½ in. to 10 in., and thickness 0.4 m. m. to 1.0 m. m.

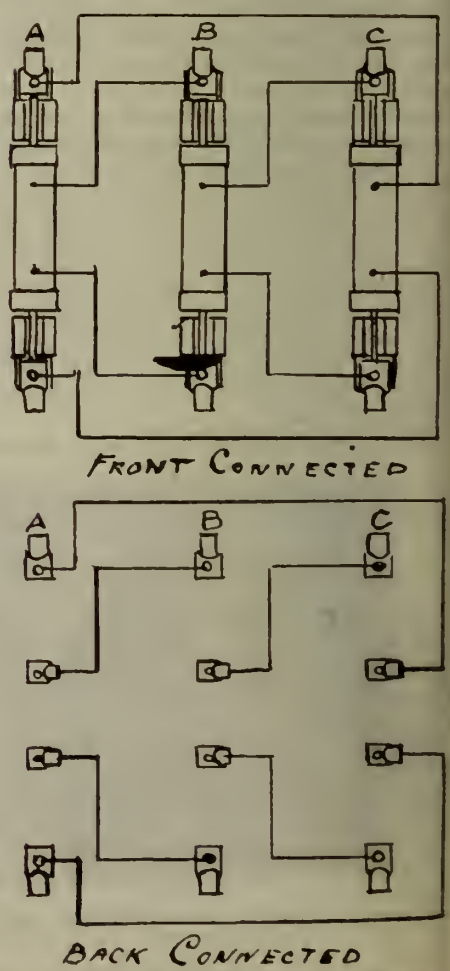
Several steel belt drives are performing good service in England where there are over 50,000 H.P. varying from 90 to over 800 H.P. drives in successful operation, some of these steel belt drives having been in operation over eight years. As steel belts may be applied in multiples there is no limit to the possible power to be transmitted.

Jones & Glassco, Engineers, St. Nicholas Bldg, Montreal, are the sole Canadian agents for this belting.

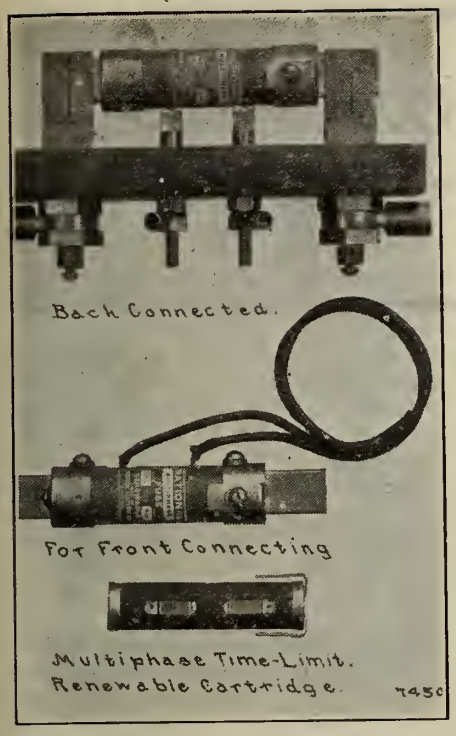
NATIONAL MULTIPHASE RENEWABLE FUSE

The Federal Electric Company of Chicago have developed with basic patent protection a low voltage auxiliary coil which is embodied in the renewal cartridge of National Renewable Fuses, and as the Cartridge can go into the case in but one position, it easily makes the auxiliary connection with the fuse case itself. Leads are then brought out for connecting the inter-phase circuit in either delta or "Y" connection and is made with either wire connections attached to the case for front connecting, or auxiliary knife-blade connections are attached for back connecting on panels, switchboards, etc.

National Multiphase Renewable Fuse, as the new device is known, serves two pur-



CONNECTIONS OF MULTI-PHASE FUSE.



VIEW OF CARTRIDGE.

poses. First, as a fuse it is so constructed that it withstands the high starting current of motors, yet protects the running load within the limits prescribed by the Underwriters' Laboratories, Inc. It is powder-packed, which is the best known fuse practice. It has the metallic "tell-tale" indicator which shows in plain view upon the outside of the fuse the rated amperage of the element with which the fuse is loaded. As the fuse is made for operation on Multiphase circuit, it acts as a circuit breaker, that is, when one fuse blows, the auxiliary device in the National Multiphase Renewable Fuse makes one of the other elements in one of the fuses blow, thereby breaking the circuit entirely and eliminating the possibility of the motor running as a single phase motor. This is really a time limit fuse and is absolutely fool-proof

The two greatest causes of motor interruption, occasioning great delays, loss in production, and costly rewinding of motors, are the overloading of fuses by placing two or more elements of too great a capacity in the fuse case and the running of motors as single phase.

WATER POWER RESOURCES

(Continued From Page 25)

the six month flow maximum power. Applying this, the figures quoted above therefore indicate that the at present recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 h. p. In other words the present turbine installation represents only 5. 9. per cent of the present recorded water power resources.

The figures listed in Columns 2 and 3 in the above table represent 24-hr. power and are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration, is definitely known or at least well established. Innumerable rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient where heads may be created by the construction of power dams, excepting only at such points as definate studies have been carried out and the results made matters of record.

The figures in Column 4 represent the actual water wheels installed throughout the Dominion. These figures should not be placed in direct comparison with the available power figures in Columns 2 and 3 for the purpose of deducting therefrom the percentage of the available water power resources developed to date. The actual water wheel installation throughout the Dominion averages 30 per cent greater than corresponding maximum available power figures calculated as in column 3. The figures quoted above therefore indicate that the at present recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 horse power. In other words, the present turbine installaion represens only 5.9 per cent of the present recorded water power resources.

The above figures may be said to represent the minimum water power possibilities of the Dominion.

As illustrative of this the detailed analyses which have been made of the water power resources of the provinces of New Brunswick and Nova Scotia have disclosed most advantageous reservoir facilities for regulating stream flow and it is estimated that the two provinces possess within their respective borders 200,000 and 300,000 commercial horse power. These figures provide for a diversity factor between installed power and consumers' demands.

Progress During Past Year

In spite of the outstanding facts that financial and commercial conditions are still far from normal and that costs of construction are almost prohibitive for all but absolutely necessary undertakings, there has been during the past year and is now, marked activity in hydro power construction. This has resulted from a variety of causes principal among which is the lack of native coal in the central industrial district and the fortunate location of economic water power sites to industrial centres.

The total hydro power development installed during the past year or now under construction represents approximately 560,000 h.p. of installed capacity. This figure includes only the initial installations of plants under construction, not their ultimate designed capacity. It is evidence of the manner in which the water power resources of the Dominion are being put to effective and productive use.

Future Growth in Utilization of Water Power

It is profitable to consider the history of water power utilization in Canada during the past few years in conjunction with the present activity with a view to making some reasonable forecast as to its probable future growth Should the rate of water wheel installation during the past fifteen years be maintained, there will be installed in 1925, 3,360,000 h.p.; in 1930, 4,110,000 h.p.; in 1935 4,860,000 h.p.; and in 1940 a total of 5,600,000 horse power. In view of the increasing appreciation of the advantages of hydro power combined with the fortunate location of ample supplies within easy transmission distance of practically every great industrial centre throughout the Dominion, there is every reason to anticipate that the rate of growth in utilization will be accelerated rather than retarded. Reference to the foregoing totals of water power available will indicate that this anticipated increase in utilization will not seriously reduce the total reserves. Canada possesses sufficient reserves of water power to meet all anticipated demands for many years to come.

AVAILABLE AND DEVELOPED WATER POWER IN CANADA

Available and Developed Water Power in Canada

Province	Available 24-hr. power at 80% efficiency. At ordinary min. flow h.p.	at est. flow for max dev. (Dependable for 6 mos. h. p.	Turbine Installation h.p.
British Columbia .	1,931,142	5,103,460	304,535
Alberta	475,281	1,137,505	32,492
Saskatchewan . .	513,481	1,087,756	.....
Manitoba	3,270,491	5,769,444	83,447
Quebec	6,915,244	11,640,052	925,972
New Brunswick .	50,406	120,807	21,180
Nova Scotia . . .	20,751	128,264	35,774
P. E. Island . .	3,000	5,270	1,933
Yukon and Northwest Territories.	125,220	275,250	13,199
	18,255,316	32,075,998	2,470,580

TORONTO NO. 1. HOLDS PICNIC

Toronto No. 1 Lodge C. A. S. E., held a picnic on Saturday July 30 at the Exhibition Park Toronto which was unanimously agreed upon as being the best ever held. A large programme of sports had been arranged, there being thirteen events in all, and each one had a well worth-while prize attached to it. One of the best was the ball game between the engineers and supply men, which resulted in a draw, thus leaving no room for any blowing by either side.

The sports being successfully carried out, and the ball game decided without any casualties, adjournment was made to the Horticultcral Building, where the ladies had prepared a very appetising re past, which was much appreciated by the tired and hungry athletes.

A goodly number of the representatives of the various engineers supply firms were present, and co-operated as usual with the C. A. S. E. with regard to prizes.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

DOUBLE ACTING COMPOUND PUMP

Question:—We have a double acting compound pump, the high pressure cylinder of which is 11 inches, and the low pressure cylinder 16 inches. The pump runs thirty double strokes per minute, the boiler pressure being 115 lbs per square inch. The stroke is 10 inches. How do you figure the horse power, and if we do run this pump instead of two simple pumps what is the gain in efficiency.

Answer:—The horse power of the pump will be the product of the mean effective pressure on the area of each cylinder, multiplied by the stroke and the number of revolutions per minute, divided by 33,000. The formula will be—M. E. P. on high × Area of high × stroke in feet × 30 ÷ by 33,000 + M. E. P. on low × Area of low × stroke in feet × 30 ÷ by 33,000 which can be combined as follows:— M. E. P. of high× A plus M. E. P. of low × A × stroke × 30 divided by 33,000. The mean effective pressure of the high will be the forward pressure on the high pressure piston minus the pressure in the low pressure receiver, which will act against the high pressure piston all through the stroke. The mean effective pressure on the low will be the forward pressure on the low minus the back pressure, which will be slightly above the atmosphere in a non-condensing pump, and 5 or 6 lbs. above absolute vacuum in a condensing pump. In the ordinary pump the steam is carried the whole stroke at full pressure and then exhausted to the atmosphere, while in the compound pump the steam is further utilised in the low pressure cylinder before being exhausted, to atmosphere or condenser. The average efficiency of the steam in small pumps does not exceed fifty per cent, while with the compound or triple pump properly proportioned this will be much improved. Some compound pumping engines are arranged with a separate cut off valve on the back of the main slide valve so that cut off can be regulated. There should be a gain of from 10 to 15 per cent. in efficiency on a compound over a simple pump.

A REFRIGERATION QUERY

Question:—What effect does oil, air or water have in a refrigeration plant, and what provision is made to remove them?

Answer:—Air, oil or water in a refrigeration machine that is designed for using volatile liquids such as ammonia, or carbonic acid, have the effect of lowering the efficiency of the machine. The space occupied by these foreign gases or substances lessens the space for action of the ammonia. Oil on the coils has the effect of insulating them, and is just as detrimental to them as it is to the heating surfaces of a boiler, as far as heat transmission is concerned. Oil is removed from a refrigerating machine by means of oil separators placed in the discharge line and water can also be trapped in these separators. Air usually rises to the top of the condenser, and can be removed from there by means of purging, which is accomplished by opening a cock on top of the condenser, and flowing through a hose into a pail of water. While there is air passing its presence can be noted by bubbles rising in the water, and as soon as the air is out, the bubbles stop.

HORSEPOWER REQUIRED TO LIFT WATER

Question:— A round tank is 12 feet in diameter and 4 feet high, and is full of water. It is pumped 20 feet above the bottom of the tank in one hour. What is the horse power required?

Answer:—We do not quite understand the question as stated above, but we will give the method of finding out the horsepower, and it can be applied to any question. One cubic foot of water weighs 62.5 lbs and if this is raised one foot high by a pump or any other means, it will require the expenditure of 62.5 foot lbs of energy. A column of water 12 feet in diameter would have an area of 113-1 square feet, and if 4 feet high a volume of 452.4 cubic feet, which would weigh 28,275 lbs. This column of water is raised a mean height of 16 feet in an hour, as we understand the question, and the work done would be 28,275×16 which is 452,400 foot lbs. As one horse power is the performing of 33,000 foot lbs per minute, and the work in question has occupied one hour the horse power will be 425,400 divided by 60×33,000 or .22 H. P.

If the work were performed in one minute it would take 13.2 H. P. neglecting friction losses.

AMMONIA AND AQUA AMMONIA

Question:—What is ammonia and aqua ammonia, and why is ammonia so well suited for refrigeration and used more than anything else?

Answer:—Ammonia is a gas composed of Nitrogen and Hydrogen, there being one part of Nitrogen to three parts Hydrogen, and the chemical symbol is NH_3. It has the property of being easily liquefied at a comparatively low pressure and possesses a high latent heat. It is these properties which make it a suitable refrigerating agent, as the fact that it liquefies at a pressure of from 150 lbs per square inch enables the compressor to be built of ordinary thicknesses of metal, and the high latent heat gives it the power of absorbing a large number of heat units per lb of gas. It has also another highly important property for a refrigerating agent, that is a low boiling point. At atmospheric pressure it boils at 28.5 degrees Fahrenheit, while its latent heat is 592.1 B. T. U. Aqua ammonia is a solution of ammonia gas and water of about 26 degrees Baume, which corresponds to a specific gravity of about .897. This is used in the absorption process of refrigerating.

DESCRIBE A SUPERHEATER

Question:—Please describe a superheater.

Answer: There are a number of superheaters on the market, and we cannot describe any particular one. The general principle of a superheater is a number of coils, usually made of copper, which are placed in the uptake or breeching of a boiler in the path of the waste gases as they go to the stack. These coils are connected to the main steam discharge of the boiler, and all the steam passes through the superheater before going to the units in which it is to be used. As the gases in the uptake are at a temperature of from 500 to 600 degrees, and the steam at anywhere from 300 to 360 degrees, the steam absorbs a considerable amount of heat from the waste gases, thus causing it to be superheated. This means that the steam is at a higher temperature than that due to its pressure, and this heat will have to be given out before any condensation can take place. This extra heat is gained at the expense of what would otherwise be a waste. Superheated steam is generally used in turbine practice, and in some forms of drop valve engines.

Queenston--Chippewa Power Project Is Visited

Even On A Short Tour The Magnitude Of The Work Is Apparent —Seldom Does A Single Job Embrace As Many Branches Of The Engineering Trades As This One—Huge Shovel Is Employed.

By J. H. MOORE

A STUPENDOUS Engineering Undertaking." "A sight never to be forgotten." "Something of which Canada can feel justly proud." The above quotations are but three of the many expressed by the party of engineers and executives who viewed the Queenston - Chippewa development on Friday, July 22nd, under special arrangements made by the Ontario section of the American Society of Mechanical Engineers.

Seldom is a task undertaken that embraces so many engineering problems as the new power scheme we are speaking of. It is hardly necessary to state at this late stage of development what prompted the scheme. Everybody knows that the water will be brought in from the Niagara River, pass through a huge canal, later creating an enormous amount of power by its very volume. The problem of cutting a canal out of solid rock was itself a great one but practically every engineering trade enters into the successful completion of this project. The mechanical, electrical, structural and hydraulic branches are the chief ones interested, with the transport, and housing problems coming as secondary, yet important considerations.

Important Figures.

Before proceeding with the story of the trip itself, we will briefly review the more important figures connected with this great power scheme. When completed the power plant will consist of 9 units with 500,000 h.p. The effective head on the water is 305 ft., and the capacity of each power unit is 55,000 h.p. The length of the river section is four miles, and the length of the canal 9 miles, making 13 miles in all. The cut in both rock and earth is enormous, being 72 ft. in the earth and 85 ft. in the rock. The concrete water channel is 48 ft. wide, and under normal operations the depth of the water in this channel will be around 30 to 35 ft.

The maximum velocity in the canal will be 10 ft. per second, and the forebay, which is 1,000 ft. long, widens from the standard 48 ft. canal section to 500 ft. at the gate house. The penstocks used are 16 ft. in diameter, and not only is every joint riveted, but it is welded as well.

The power house when completed, will be 600 ft. long and 185 feet high from its base. They figure the total earth excavation will be 13 million cubic yards, and the total rock excavation 4 million cubic yards. Work was really commenced on this project in May, 1917, and since that time great progress has been made.

To illustrate the detail necessary in a project of this kind, we will review very briefly some of the arrangements necessary to carry on the work. Seventeen highway and railway bridges have been built, two dredges and 14 shovels are used, also a cableway excavator. The writer viewed with interest the largest electric shovel ever made, working like a trojan on the job. Each bucket full means 8 cubic yards of earth and rock, and in some cases the material is lifted as high as 80 ft. Three trips of this shovel and a dump car is full of material.

Eighty miles of railroad track have been laid, and over some of these lines passes more traffic than on many a line owned by a large railway company. 24 electric locomotives are used, 26 steam locomotives, and over 320 air dump carts.

The various concrete plants have capacities as follows: The crusher plant has a daily capacity of 3,000 cubic yards, the sand storage a capacity of 100,000 cubic yards, with a stone storage capacity of 250,000 cubic yards. There are 9 stationary concreting plants, 4 movable paving plants, and 9 movable lining plants.

Compressed Air.

The compressed air wants are well looked after, there being some 26 units electrically driven, which provide 30,000 cubic ft. of free air per minute. Over 500 temporary buildings are erected, and there are five camp districts for employees, providing accommodation for 6,000 men. With few exceptions electric power is used to drive the machinery at work, and the normal load for constructional purposes is 10,000 K.W.

Leaving these amazing figures to sink in, we will proceed to tell the story of the actual visit. The first place inspected was the power house. Here was to be seen some wonderful concrete work, both in the building itself and in the draft tubes, and ice chute provided. The form work on some of this work is nothing short of marvellous and shows what really can be accomplished with concrete. Without dwelling at length on any particular part of this portion of the plant, the party viewed the turbines, the various electrical units in connection with it. The penstocks with their massive proportions and extreme height came in for quite a lot of comment, and the men working on the face of the solid rock looked like mere ants scrambling to and fro.

After dinner the screen house was inspected together with the wonderful system of handling the pouring of concrete. The method of transporting the various materials used is wonderful. Conveyors are used for everything. Central stations distribute the prepared material to the different parts of the job, and once started, the flow is continuous until that particular portion is completed. The pouring tubes around this job are almost numberless, and they are controlled by gates operated at some central spot. In the case of the sand and stone, they go to a storage station, from there to the mixer or to some subsidiary point, but in the case of the cement, a conveyor takes it direct from the car to the various mixing plants.

Change in Shape.

From this point on the party stopped numerous times, inspecting the canal at different points. At one portion the canal channel changes from a trapezodial shape to a rectangular shape, or vice versa, as you would prefer. This is where the old bed of the Niagara River is crossed, and instead of a rock cut, this portion is an earth fill, this fact accounting for the change in shape. The concrete work is so arranged that the form again gradually assumes a rectangular section as rock is once more met with.

At another point in the canal, a certain necessary curve has been so figured out that the heat loss suffered in winter by the friction of the water passing round this curve will prevent thin ice sticking to the side of the channel. Readers of course will not care to go into how this was arrived at, but it shows how much care has been exercised in the preparation of the canal.

When completed the channel will have a gradient of 1 ft. per mile, and the water will flow at a rate of about 7 miles per hour. At first only two power units will be installed, and a flow of water 6,500 ft. per second will be all that is required for these units.

In some of the concrete work on the canal channel portable forms are used, this being on the trapezodial shaped portion. These forms are merely placed on top, the concrete poured, and in twelve hours the form can be safely lifted. For the main channel, that is the rectangular shape, special concrete pouring machines are used, these having steel forms on either side which are set the correct distance apart, and poured right from the machine, which is self contained. This machine runs on portable tracks on the bottom of the canal channel, and it is a treat to see it work.

The method of blasting rock is particularly interesting. Portable air drills go down for a depth of between 20 to 30 feet in the solid rock, and holes are drilled about every 6 feet across the channel bed. After drilling, the various holes are loaded with explosives, "Forcite"

(Continued on page 43.)

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	29 50
1¾-in.	29 75	27 00
2 -in.	29 25	25 50
2½-in.	44 75	31 50
3 -in.	49 25	40 00
3¼-in.	.....	48 50
3½-in.	63 50	43 50
4 -in.	85 00	55 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$5 25	$5 25
Plates, ¼-in. up	4 75	4 75

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	27.84
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.

4½-in. and larger, 40%.

4-in. and under, running thread, 20%.

Standard couplings, 4-in. and under, 20%.

4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union. 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ....base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15
Standard	0 15 to 0 40
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7-16 and over	—5
Machine bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 27½
Solder, guaranteed	29½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$32 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	34 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	40 00	42 00
Copper sheet, planished, 16-oz. base	46 00	48 00
Braziers', in sheets, 6 x 4 base	38 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13½
X L C R	14½		

Colored

Lion	13½	Popular	10½
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Toronto
Tin	$39 00	$40 00
Spelter	7 75	7 50
Lead	5 75	7 50
Antimony	8 00	8 25
Aluminum	34 50	30 00

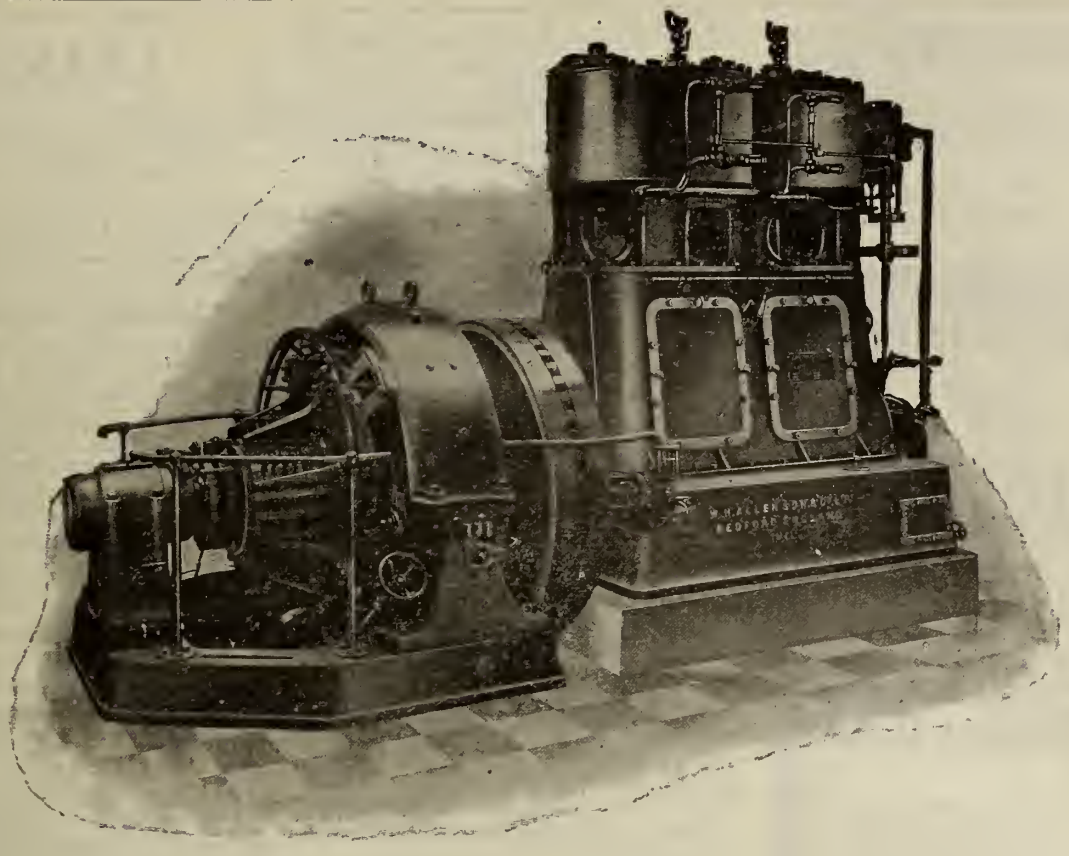
Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.

Cut sheets to size, 1c lb. extra.



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Allen "Open" and "Enclosed" high-speed engines have a world-wide reputation. They are being extensively used by the British and other principal Naval Powers of the world, as well as by the Mercantile Marines of all Countries, for driving auxiliary machinery on board ship.

Many thousands of these engines have been supplied, working in connection with installations of electric light, power and traction, serving in Municipal Corporations' and Electric Lighting Companies' Stations, Dockyards, Arsenals, Mills, Factories, Mines, Steel Works, Quarries, Sugar Refineries, Chemical Works, etc., and are giving uninterrupted service at low cost.

Allen Engines are suitable wherever high speed, high efficiency engines are required.

Allen Specialties

Steam Engines
Steam Turbines
Continuous Current Dynamos, Motors and Generators
Controllers and Switchgear
Fans
Centrifugal Pumps
Condensing Plants

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Montreal				Victoria

Fairbanks-Morse

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Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

"UNIFIC" WATER GAUGE

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GLASSES

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

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CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

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TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

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1 H.R.T. BOILER—72-IN. x 16-FT. SHAKER grates and stack, complete; 125 lbs.
1 H.R.T. BOILER—60-IN. x 14-FT., 120 pounds. Apply, mentioning Power House to Wilson-McGovern, Ltd., Lumsden Bldg. Toronto.

THE JOHN INGLIS CO., LTD., ENGINeers and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention Power House.

FOR SALE—A NUMBER OF SECOND-HAND machine tools in excellent condition; these may be inspected at our works. Apply, mentiontioning Power House, The Waterous Engine Works, Co., Limited, Brantford, Ont.

STEAM ENGINES, BOILERS, HEATERS, tanks, stacks, pumps and condensers, transmission and elevating machinery, safes, vaults and vault doors; catalogue and specifications sent on request. Apply, mentioning "Power House," to Goldie & McCulloch Co., Ltd., Galt, Ont. (pfh)

SAWMILL MACHINERY MANUFACTURED by sawmill machinery specialists. Apply, mentioning Power House, The E. Long Manufacturing Co., Limited, Orillia.

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Does your chimney need repairing? Experienced chimney foreman and expert repair man is open for engagements. Put your problems up to me. Rates reasonable.
Box 203, Power House.

EQUIPMENT

WE BUY IDLE EQUIPMENT OR MACHinery; call or write, mentioning Power House. H. W. Petrie, Ltd. Toronto.

SITUATIONS WANTED—MALE

STATIONARY ENGINEER (2ND CLASS)—would appreciate steady position in country; references A1. Apply, mentioning Power House, to Box 218, Globe.

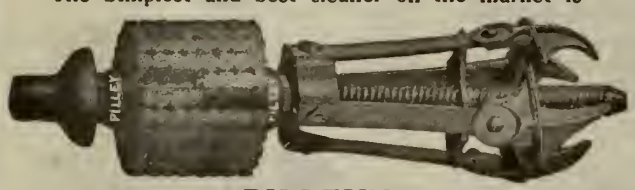
MECHANICAL ENGINEER, 29, FIRST-CLASS stationary engineer's license for Ontario, 10 years' power plant experience, saw-mill and paper mill; specialist in making repairs and operating plant economically, desires permanent position with large saw-mill or paper mill, preferably in New Ontario. Apply to Box 202, Power House.

MACHINERY FOR RENTAL — WE WILL rent by the month motors, hoists or contractors' plant of any description. Apply, mentioning Power House, H. W. Petrie, Limited, Toronto.

ELECTRIC MOTORS—NEW AND SECONDhand; electric machinery repaired; we also buy motors. Apply, mentioning Power House, The Electrical Engineering Co., 122 Wellington West, Toronto.

FOR SALE—ONE 16-INCH, ONE 24-INCH Sheldon exhaust fans, practically new. Apply, Box 205, Power House.

The Simplest and best cleaner on the market is



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Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
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Eastern Office: 71 Fulton St., New York.

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Consulting Refrigerating Engineers
358 Beaver Hall Square, MONTREAL, Canada

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
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Special Castings — Pumps, Hoists, Valves, Boiler Fronts
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Send Blueprints for Quotations. *Write for our latest catalogue*

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
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Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System

INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE
OF POWER HOUSE

QUEENSTON-CHIPPEWA POWER PROJECT IS VISITED

(Continued from page 39.)

being chiefly used, and the charge is set off electrically. The huge 8 cubic yards electric shovel then comes along and bites right into that depth.

The dredge "Cyclone" works away at the inlet to the canal, clearing away the earth, so as to allow the proper volume of water to pass through. In fact, to tell the tale properly and in detail would take a volume in itself. Even the huge stone crusher could take a lengthy description. There it appears, a massive mass of machinery, nothing to see inside, but crunch, crunch, crunch, it goes on, eating rocks and breaking them up like we would an ordinary chocolate. There is a spirit of romance to the whole venture, and one cannot help but feel the thrill of at least having seen such a wonderful work being performed.

Col. Ellis was the chief guide, being ably assisted by Mr. Tobias, one of the designing engineers on the work. Twenty-one took advantage of the trip, these being H W. Price, Professor of Electrical Engineering, University of Toronto; W. F. Sutherland; Professor Gilchrist, of the Physics Section U. of T.; G. M. Smith; L. Tolson, and J.H. Moore, all of Maclean Publishing Co.; Col. A. D. Lepan, Supt. of Bldgs., U. of T.; Mr. Spradbron; Mr. Lewis, Supt. Machine Shop, J. Inglis Co.; Mr. Quesnell, boiler inspector; Mr. Howard, John Bertram and Sons, Dundas; Mr. Graham of the same firm; Prof. Angus, professor of mechanical engineering, U. of T.; Harry Angus, Senior, retired constructional engineer; G. H. Raitt, Massey Harris Co.; Chester B. Hamilton, Jr., Hamilton Gear and Machine Co.; Mr. Crane; Mr. Boswell and Mr. Moody of Powley and Townsley, Toronto.

ANNOUNCEMENT

The Canadian Chicago Bridge and Iron Company, Limited, of Bridgeburg, Ontario, and Montreal, Quebec, has changed its corporate name to Horton Steel Works, Limited, according to an announcement made by C. H. Scheman, general manager of the company.

The new name has been selected in honor of the late Horace E. Horton, who founded the organization in the United States in 1865. The Canadian organization was first incorporated in 1913 and the plant at Bridgeburg, Ontario, was constructed in that year.

Mr. Horton was one of the pioneer engineers of North America. Starting with a timber bridge at Orinoco, Minnesota, in 1865, Mr. Horton developed a large business in the design, fabrication and erection of bridges, steel tanks, etc. In the early nineties, he revolutionized the steel tank business by inventing the hemispherical-bottom elevated tank of which thousands are now in use throughout the world. A few years ago his son, Mr. George T. Horton, now president of the Horton Steel Works, Limited, invented the elliptical bottom tank with riveted steel riser which was a further advance in the art of steel tank building.

The corporation has supplied the railroads and many industrial organizations of Canada with plate metal products. The company has a tried organization with its own operating officials, a complete plant, erection forces and contracting organization. In addition to Mr. Scheman, Mr. G. S. Sangdahl is district sales manager at Montreal, Mr. C. C. Gregory is manager of plant, and Mr. F. E. Gregory superintendent of erection. The main office and works are at Bridgeburg, Ontario.

NEW BOOKS

The Combustion Engineering Corporation have printed in booklet form the paper read before the American Iron and Steel Institute in New York in May last. This is stated by the Combustion Company to be the most complete summary of powdered coal progress that they have yet issued. The paper describes in detail the various types of equipment, the results achieved up to the date of the paper, and a general history of the progress of this new method of using coal fuel. The booklet is issued with the compliments of the Combustion Engineering Corporation, Broad Street, New York.

DEFEND YOUR STEAM

The Magnesium Association of America have issued a book with the above title, setting forth the merits and uses if 85 per cent magnesia. In the preface it is stated that the book is for the use of the architect, engineer, and owner, to assist them in the conservation of fuel by proper insulation of steam pipes, boilers and any surface which might radiate heat where not so required. Short articles on heat insulation and losses, and the proper type of insulation to use in different situations and circumstances are indicated. A goodly number of illustrations are included, several of them being of plants in Canada.

STEEL SLITTING SHEAR

A special design of bench shear intended for use in machine shops, garages, etc., has recently been developed by the Dries & Krump Manufacturing Co., of Chicago, Ill. It has a capacity for cutting bars up to 3-16 by 2 inches, and will slit steel sheets up to No. 10 gauge. The shear is of all-steel construction, the frame being pressed out of one piece and offset to allow working on sheets of any length. Geared leverage is provided. The blades are 4½ inches in length and 5-16 inch thick, made of crucible steel. All parts are made interchangeable.

--and who wants to waste steam at present prices of coal?

With coal costing as high as $13 a ton—and often hard to get at any price—it is far cheaper to put in enough Steam Traps Sarco to stop loss of steam through condensation than to stand the alternative of big waste at the coal pile.

Steam Trap Sarco puts the whole question of proper trapping vs. waste of coal on an entirely new basis—

It pays for itself at points where a Big Trap wouldn't Be Justified.

You can put in three Sarcos for the cost of just one bucket or floor trap—thus for the same expenditure saving three times as much steam and therefore three times as much coal. Because it costs only one-third as much, a Sarco will quickly pay for itself at points where the expense of an old-style trap wouldn't be justified.

Sarco is more dependable and efficient than old-style traps. It operates automatically—on a simple yet extremely sensitive and responsive system of liquid expansion and contraction. So positive in action that not an ounce of live steam can escape from one year's end to the other.

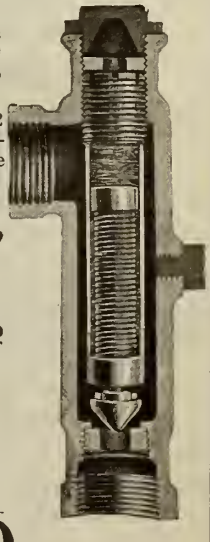
Drains off all condensate as fast as it forms—and immediately returns it to the hot well—while still hot, thus requiring less coal to convert it back into steam. And never any water (condensate) left in the pipes to freeze overnight or over Sunday.

30 DAYS' TRIAL.

We are ready to let Sarco demonstrate its superiority and economy right in your own plant by sending you one on 30 days' free trial without a cent in advance. If for any reason you aren't satisfied with its performance, you can return it and it won't cost you a cent.

Made in sizes ⅜ in. to 3 in. for any given pressure up to 200 pounds.

Booklet No. J-12 and full particulars about our free trial on request.



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Steam Trap SARCO

"PREPAREDNESS is ever the practical secret of success.

Without it opportunity means little"

Prepare yourself now for that bigger business "just ahead." If you are paying overhead in your power plant for one or two useless old "relics" why not replace them with machines that produce. Whether new or used you can depend upon our equipment to give the utmost value for the money it costs.

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WHY DOES A BELT CLIMB

Editor. Power House:—

I have just finished a big discussion with a group of engineers on the question of belts running to "the high side of the pulley" as they put it, and I herewith give you my views on the problem.

I would like to say that such expressions as "the belt will run to the HIGH side" or "the belt will run UP" are erroneous expressions because the belt only runs "UP" or to the "HIGH" side SOME times; depending on what causes the UP or HIGH sides.

Now what a belt always does without fail is to run to the LARGEST diameter; and that for good and scientific reasons.

When one edge of a belt runs on a larger diameter, that edge of the belt is pulled over the pulley at a higher rate of speed than the other edge which produces a bending effect edgewise on the section of belt approaching the pulley, thereby CHANGING THE ANGLE at which the belt rolls onto the pulley surface. This new angle of approach cuts the belt across the pulley face, until the centre of the belt has reached the greatest diameter of the pulley where both edges will travel at the same speed and the belt will approach the pulley in a straight line and remain in that location. This is the principle of the crowned pulley and because engineers are so accustomed to seeing belts climb up onto the high part of the pulley face, many of them very wrongly come to the conclusion that the belt will climb onto ANY high portion of the pulley face

If two pulleys with straight faces are mounted opposite each other on shafts that are out of parallel but in the same plane the belt will run off the low side always instead of climbing to the high; for the principle is the very same as if the belt were stationary and the pulley were rolled along the belt, it would roll off the belt on the side towards which its angle inclined.

Now try that same test on a crown-faced pulley, only instead of rolling it along a belt, roll it along a railway made of two small strips of wood or metal laid side by side on the floor a few inches apart. The pulley will be found to straighten itself on the track even if started off on an angle, and to follow the track even if the track be curved—within reason of course.

The claim made by some of my friends that "mechanical action takes place along the lines of least resistance" is perfectly correct, but the belt is FORCED onto the larger diameter by the power of the motor which is driving it. The principle involved is the principle of the screw and while a house-jack would more easily lower the building than raise it, yet if the force driving the screw is applied in the lifting direction then UP the building must go.

Yours very truly,
R. Manly Orr.

1551 Granville Street,
Vancouver, B.C., Canada.

Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap

Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admissions of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds.

Being open at starting, it cannot become air bound, this doing away with air cocks or vents — Does Not Freeze.

It is capable of draining from 900 to 1,500 feet of one inch pipe.

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to

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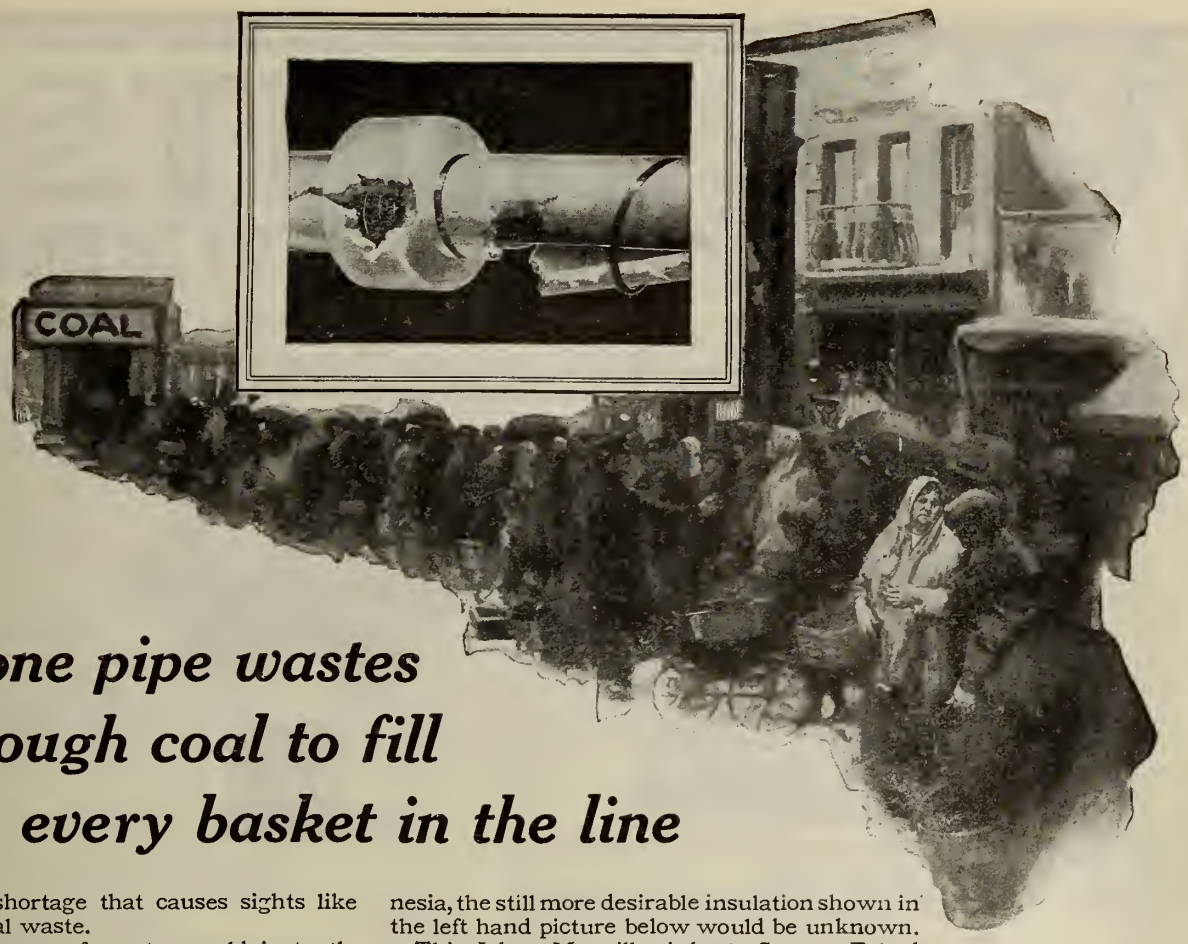
If your dealer does not sell it, write direct. No. 2



This one pipe wastes enough coal to fill every basket in the line

From a painting by Howitt showing one of the coal lines during the "shortage" when even limousines called daily for the allotted bushel. And yet the majority of people in the line were guilty of wasting tons of coal in the manner described.

IT isn't coal shortage that causes sights like this—it's coal waste.

For a sealing up of waste would instantly double our available coal supply.

But all wastes are not in homes—many power plants waste car after car of coal through pipe insulation that is faulty, physically weak or improperly applied.

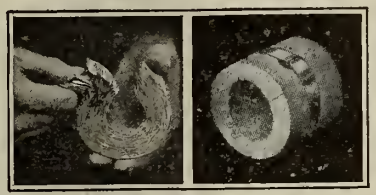
This is largely because in the early days pipe covering simply meant putting something on heated surfaces to keep some heat from escaping. Buyers neither asked nor expected assurances of how much it would save. So when Johns-Manville developed accurately rated insulation, engineering supplanted guesswork.

You can now know what bare heated surfaces and pipes are costing—also to what extent the insulation you now have is effective as a heat saver.

But had Johns-Manville been content to stop its research after high heat savings had been achieved, as in 85% Magnesia, the still more desirable insulation shown in the left hand picture below would be unknown.

This Johns-Manville Asbesto-Sponge Felted Insulation marks the success of an endeavor to increase *the life* of insulation without sacrificing heat saving efficiency. It is more durable than the older moulded forms for it is built up in felted ply form so that it does not grind away under vibration, or in handling, and more remarkable still—it shows the highest heat saving efficiency of all commercial materials.

Look about you for bare hot surfaces. You can be fairly certain that the heat they waste will soon pay the cost of insulating them with the materials below which we will prescribe and apply for you.



Showing how the felting of Asbesto-Sponge gives flexibility so vital to long life.

Johns-Manville 85% Magnesia—the standard of the moulded class of insulations.

Other Johns-Manville Insulations *include Asbestocel of the cellular type, Anti-Sweat to prevent condensation on cold-water pipes, Zero Insulation for cold-water pipes, Ammonia Insulation, Underground Conduit Insulation, Furnace and Boiler Insulation, and Insulating Cements.*

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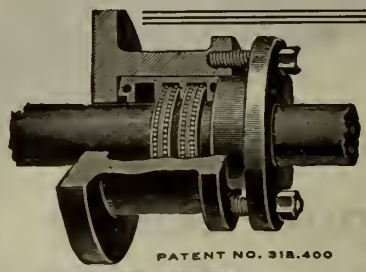

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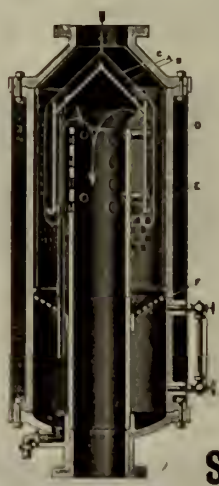

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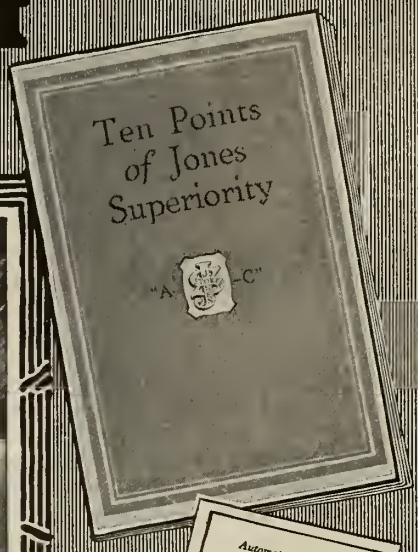

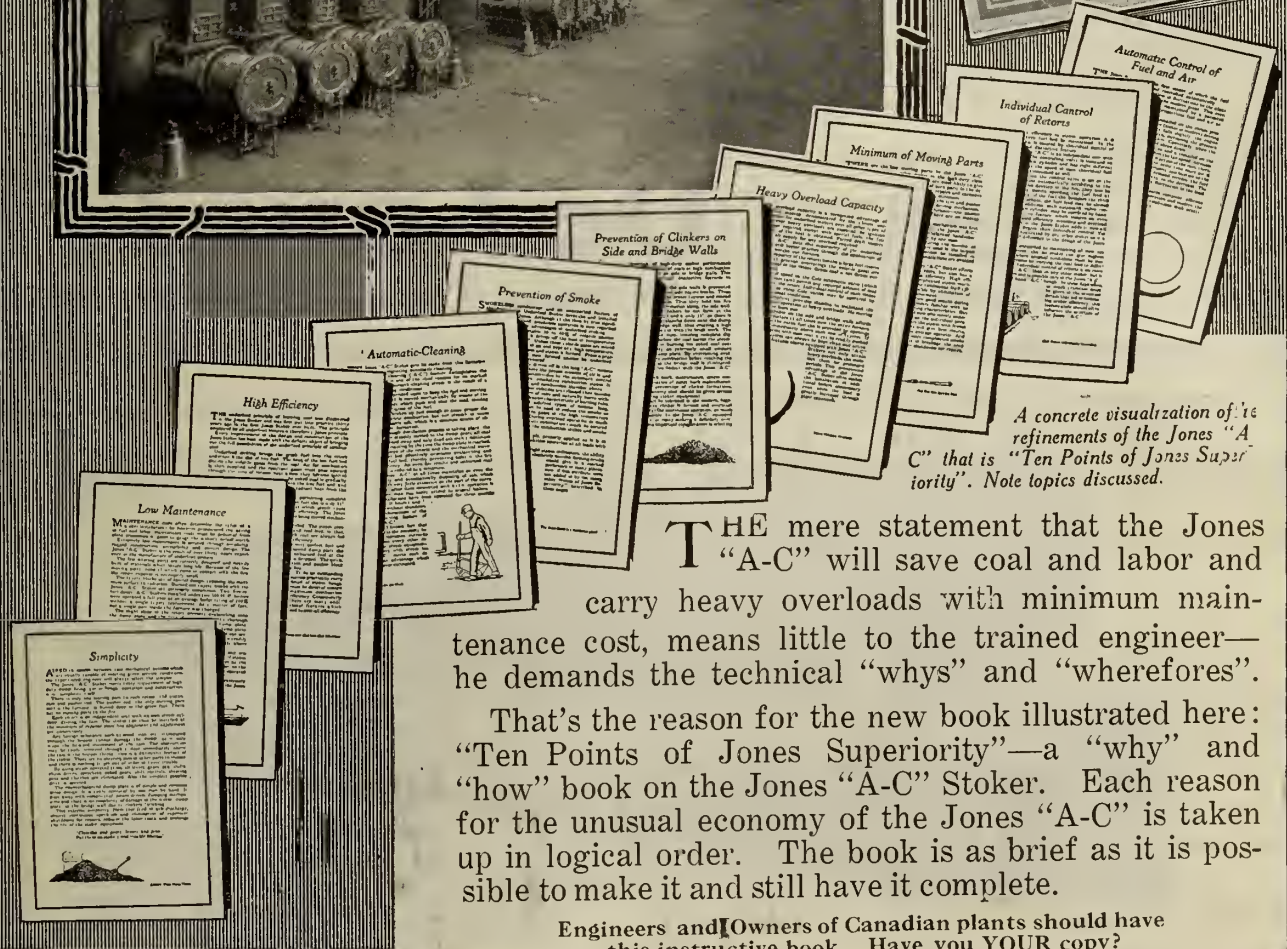

A concrete visualization of the refinements of the Jones "A-C" that is "Ten Points of Jones Superiority". Note topics discussed.

THE mere statement that the Jones "A-C" will save coal and labor and carry heavy overloads with minimum maintenance cost, means little to the trained engineer—he demands the technical "whys" and "wherefores".

That's the reason for the new book illustrated here: "Ten Points of Jones Superiority"—a "why" and "how" book on the Jones "A-C" Stoker. Each reason for the unusual economy of the Jones "A-C" is taken up in logical order. The book is as brief as it is possible to make it and still have it complete.

Engineers and Owners of Canadian plants should have this instructive book. Have you YOUR copy?

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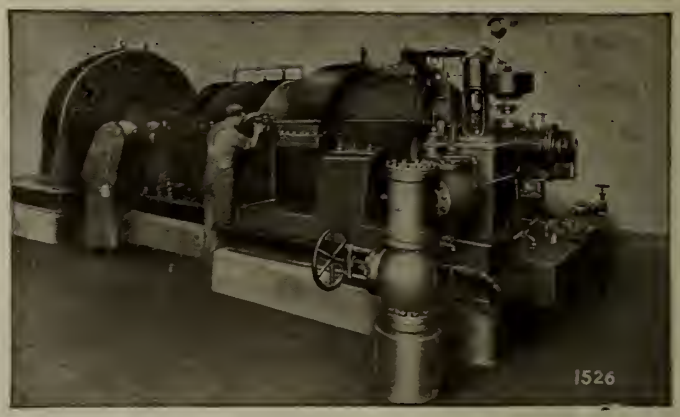
JONES "A-C" STOKERS

Power *For* Auxiliaries



THIS 1500-KW., De Laval geared turbo generator supplies direct current for the operation of auxiliaries in the Delray Plant of the Detroit Edison Company. The turbines operate on steam at 225 lbs. pressure and 210 deg. F. superheat. The steam is exhausted into a varying vacuum of from 24″ to atmospheric exhaust. The condenser is a barometric condenser and the circulating water used is the condensate from the main generating units.

This arrangement gives high plant economy combined with the flexibility and easy control of electric driven auxiliaries.

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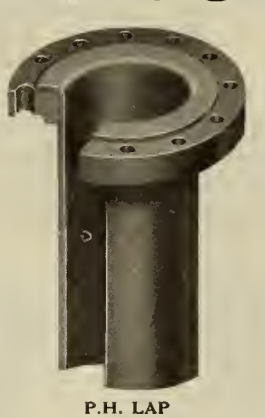

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P H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

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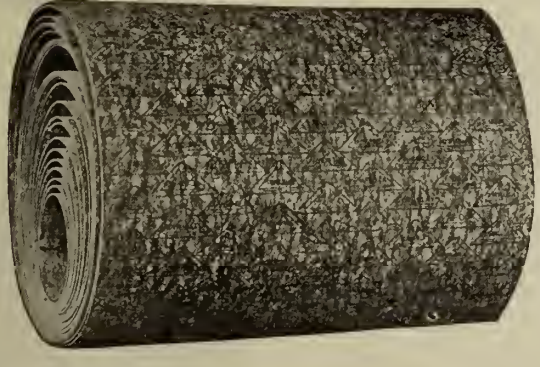

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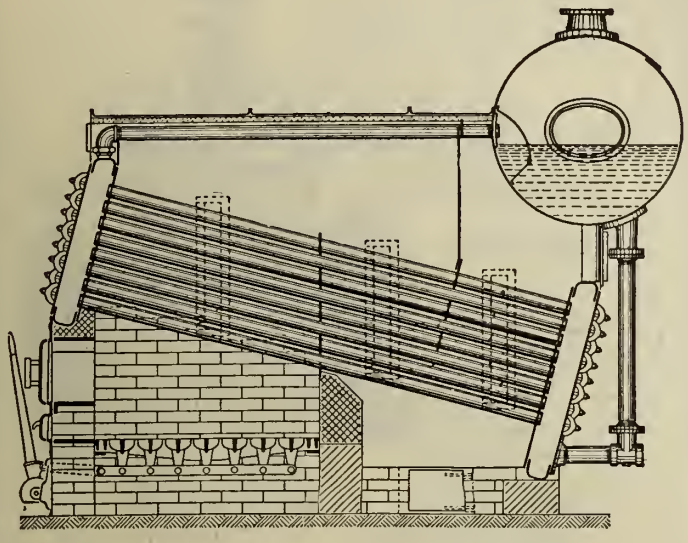

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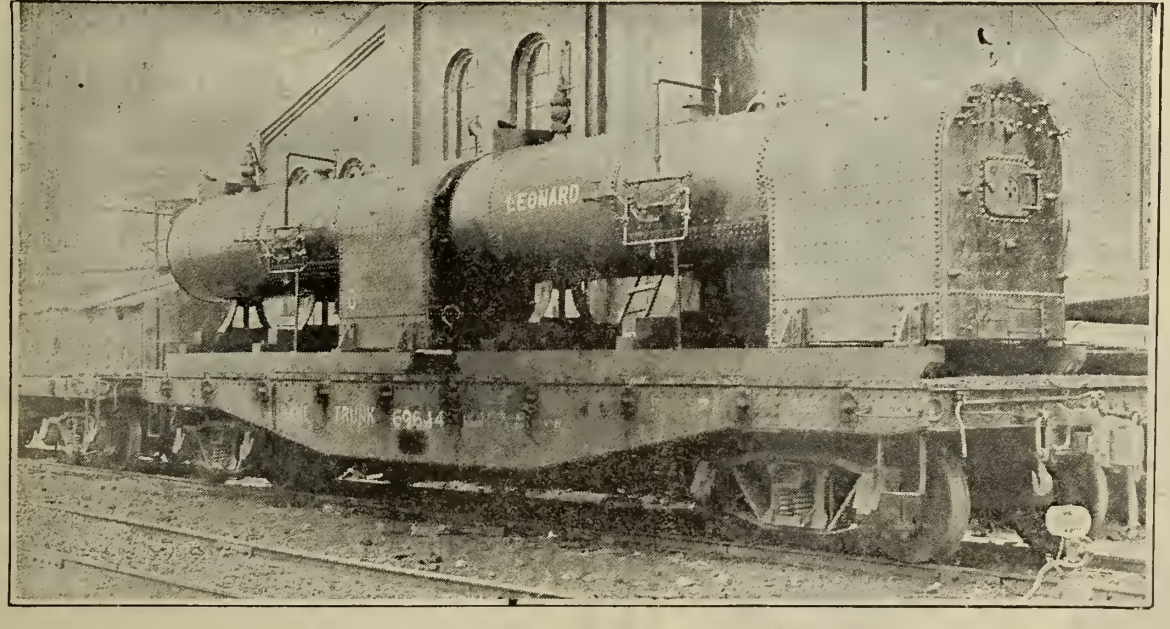

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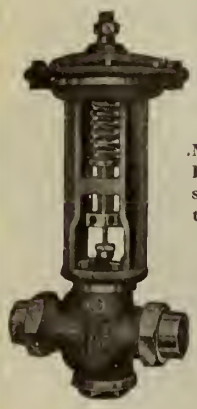
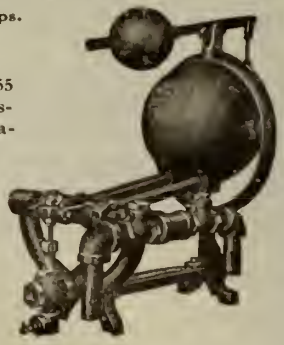


Mason Pump Pressure Regulators and Reducing Valves, Reilly Feed Water Heaters and Grease Extractors, New Bundy Return Steam Traps.

Mason No. 55 Pump Pressure Regulator.



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It is compact and self-contained, without levers, weights or projections.
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Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

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This insures maximum efficiency. Finally, the guiding force of the Copes is great in proportion to the internal resistance of the regulator, so as to insure smooth and continuous opening of the regulating valve and not a "step by step" motion."

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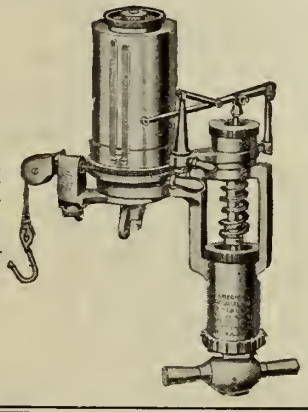

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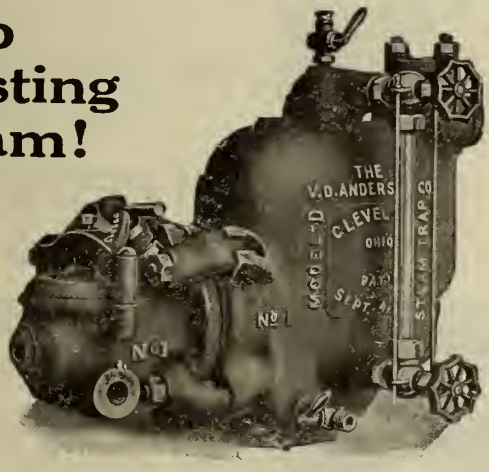

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From the day you install an Anderson Steam Trap you will notice a difference. That difference lies in its absolutely tight action. Never will you find an Anderson that fails to deliver *dry steam* under every condition. It is positive proof against break-downs from accumulated moisture. Our catalog contains a full description of the Anderson—Write for it to-day.

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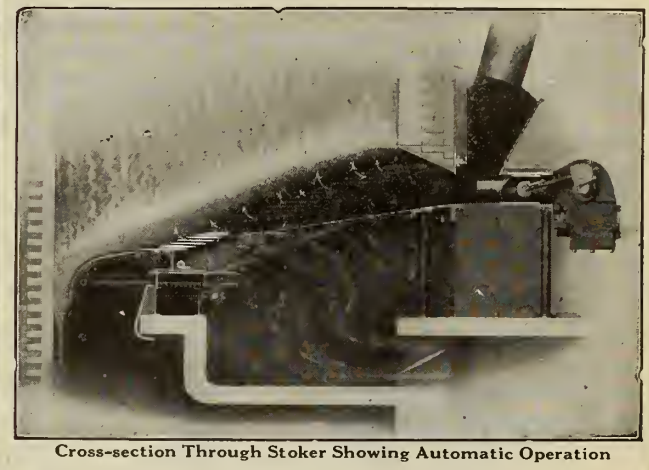

Cross-section Through Stoker Showing Automatic Operation

No device has shown itself better adapted to burn any available coal than the

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Low-grade coals—those high in ash—in sulphur and clinker-forming qualities—can be handled successfully for the following reasons:

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All parts made to gauge and interchangeable. Give us opportunity to figure on your pumping requirements.

DUPLEX POWER PUMPS

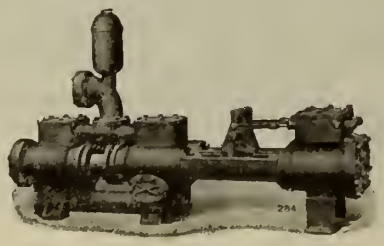


FIG. 7284
BOILER FEED AND GENERAL SERVICE PUMPS
Direct Acting Steam Pumps
For All Conditions of Service and for All Industrial and Public Utility Purposes.

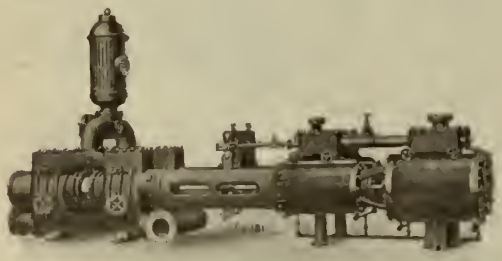
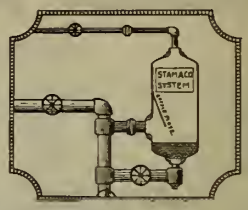


FIG. 7581
WATER WORKS PUMPING ENGINE
Full Line of Water end Patterns Up to and Including Capacity of 5,000,000 U.S. Gallons Per 24 Hours

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

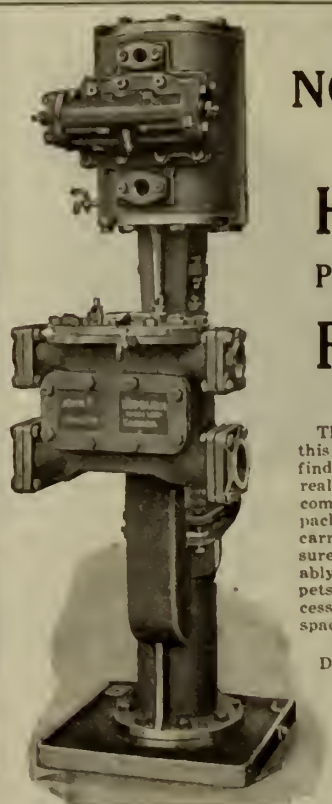
THE STAMACO SYSTEM



Why waste fuel to remove sediment from your boilers? A leaky valve is a big loss. How about the blow-off valve when opened?
STAMACO eliminates blowing down!
What is Stamaco? — It is a simple device which when attached to your boiler, will enable you to run your plant to its full efficiency by automatically keeping the boiler clean, without the use of any other agent.
No blowing down.
No more washing out.
Further details on application
Sales Agents for PLIBRICO Jointless Fire Brick

STAMACO THE SYSTEM THAT SAVES

Beveridge Supply Co., Ltd.
Montreal



NO EXCUSES
With the
HEPBURN
Patent Vertical Ram
FEED PUMP

There are no excuses attached to this Hepburn Patent Pump. You'll find that out if you give it some real work to do. It is a sturdy, compactly constructed, outside packed type for Feeding Boilers carrying the highest steam pressures. The construction is remarkably simple and eliminates all tappets and levers. Every part is accessible, and it takes little floor space in the Power House.

Duplex Pumps, Vertical Engines, Compressors, Hand and Electric Overhead Cranes for Power House Service are also products of the Hepburn plant.

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET, TORONTO, CANADA

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor. Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
Arthur S. Leitch Co., Ltd., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto.
Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Rochester, N.Y.

AIR METERS
Bailey Meter Co.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ARCHES, BOILER AND COMBUSTION
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFINGS
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
W. J. Brown (Tucks), Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont
R. C. Miller Oil & Supply Co., Ltd., Montreal.

ASBESTOS PACKED COCKS
Beldam Asbestos (Canada) Co., Toronto.
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BALATA BELTING
W. J. Brown (Tucks), Montreal.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Co., Toronto.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS, BRASS
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevent Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLES
Jointless Fire Brick Co., Chicago, Ill.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.

CHIMNEYS
Arthur S. Leitch Co., Limited, Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Darling Brothers, Ltd, Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.

R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOSETS
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD PIPE BENDING CO.
The Tube Pipe Bending Co., Toronto, Ont.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal Que
The John H. McGowan & Co., Cincinnati,
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal Que.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke ue.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MAKINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd. Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works Ltd. Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London Ont
Sturtevant Co., B. F., Toronto, Can.

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Darling Bros., Ltd., Montreal, Que
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
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Jas Morrison Brass Mfg Co. Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The Montreal.
Sturtevant Co., B. F., Toronto, Can

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que
Waterous Engine Works Co., Brantford
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

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Wm. B. Scaife & Sons, Pittsburg, Pa
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Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

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Laurie & Lamb, Montreal.
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Mason Regulator & Eng. Co., Ltd., Montreal.
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Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Mackinnon Steel Co., Ltd., Sherbrooke
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Shell Bar Bolco Supply, Ltd., Toronto.
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Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK, PLASTIC
Beveridge Supply Co., Montreal
Beteon Plastic Fire Brick Co., Rome, N.Y
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
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FITTINGS
Crane's Limited Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
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FLANGED STEAM FITTINGS
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Kerr Engine Co., Walkerville, Ont.

FLANGES
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Kerr Engine Co., Walkerville, Ont.
Page-Hersey Tubes, Ltd., Toronto Ont

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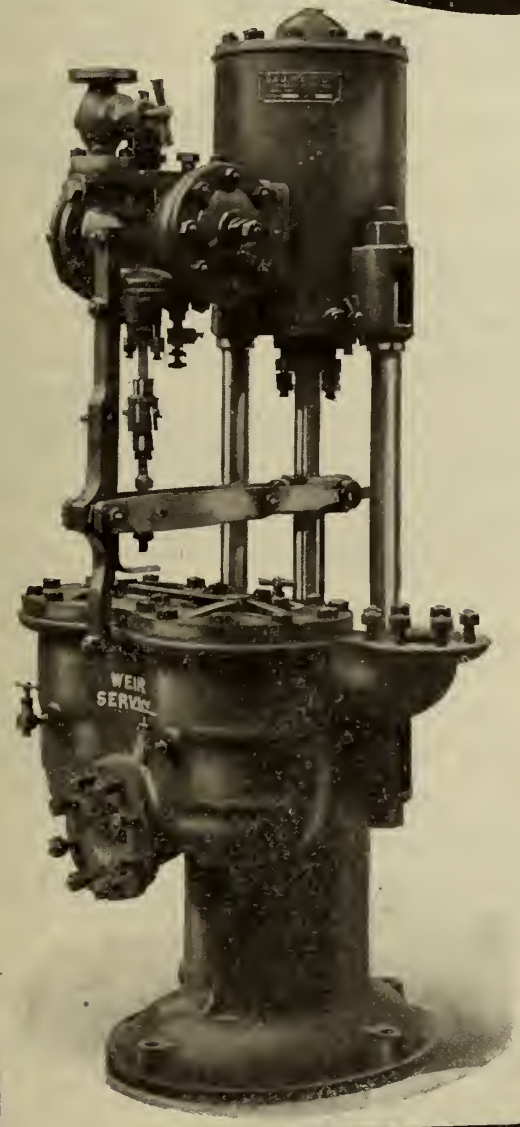

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Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GASKETS, LEAD, COPPER AND LEATHER
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Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Can. Steam Boiler Equip. Co., Toronto.
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Shell Bar Boico Supply, Ltd., Toronto.
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Shell Bar Boico Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

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Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GREASES
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Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

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J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
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Can. Link-Belt Co., Toronto, Ont.
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INSULATORS
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KEROSENE TANKS
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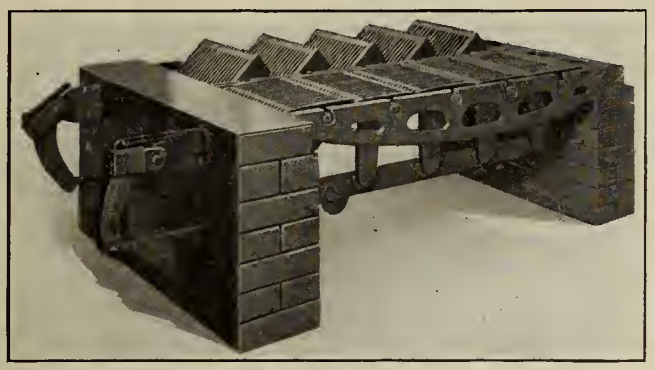

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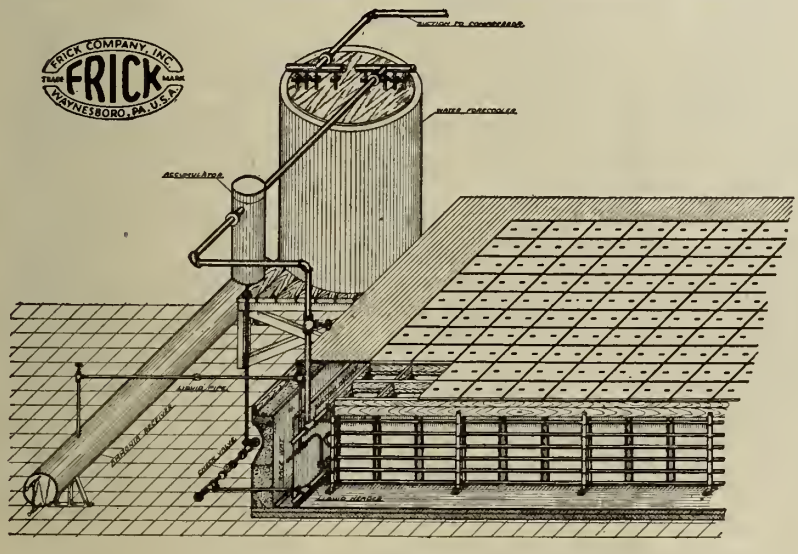

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Shell Bar Boico Supply, Ltd., Toronto.

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PAINTS
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PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE REGULATORS
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay
Frick Co., Waynesboro, Franklin Co., Pa

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal. Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton
The Fisher Governor Co (Inc.), Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, VACUUM
American Steam Pump Co., Battle Creek
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Yarnall-Waring Co., Philadelphia, Pa.

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American Steam Pump Co., Battle Creek
Darling Bros., Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

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Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

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RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que
Sarco Co., Inc., New York, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
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RAGS
Shell Bar Boico Supply, Ltd., Toronto.

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Frick Co., Waynesboro, Franklin Co., Pa
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa

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Can. H. W. Johns-Manville Co., Toronto.
Dominion Flow Meter Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

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Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Jamison Cold Storage Door Co., Hagerstown, Md.

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Boving Hydr. & Eng. Co., Ltd., Lindsay
Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

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S. F. Bowser Company, Ltd., Toronto.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
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REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

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MacKinnon Steel Co., Sherbrooke, Que.

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Can. Link-Belt Co., Toronto, Ont.

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Beldam Asbestos (Canada) Co., Toronto.
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Can. Link-Belt Co., Toronto, Ont.

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Can. Link Belt Co., Toronto, Ont.

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R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

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Waterous Engine Works Co., Brantford.

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Toronto.

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Goldie & McCulloch Co., Galt.
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Waterous Engine Works Co., Brantford.

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SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Can. Fairbanks-Morse Co., Montreal
Smart-Turner Machine Co., Hamilton
Waterous Engine Works Co., Brantford

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Can. Link-Belt Co., Toronto, Ont.

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Jeffrey Mfg. Co., Montreal, Canada
Waterous Engine Works Co., Brantford.

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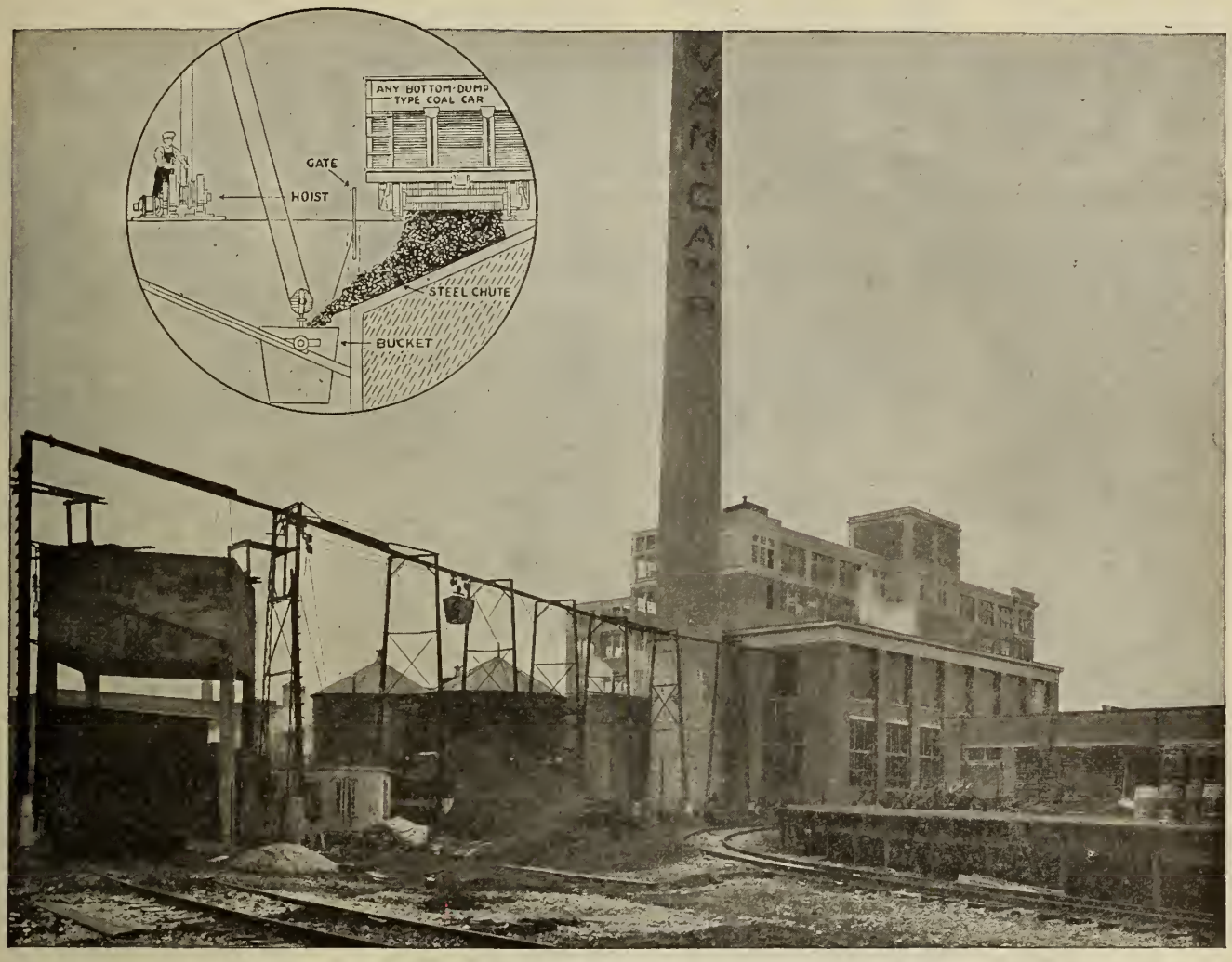
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.



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Penberthy Injector Co., Windsor.
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MacKinnon Steel Co., Sherbrooke, Que.

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Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
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Goldie & McCulloch Co., Galt.
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The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

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Waterous Engine Works Co., Brantford.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.
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Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.

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Mason Reg. & Eng. Co., Ltd., Montreal.
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Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

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Sarco Co., Inc., New York, N.Y.

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Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville

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Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
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Mason Regulator & Eng. Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

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Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
D'Este Co, Julian, Boston, Mass.

TACHOSCOPES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

TRAPS, VACUUM
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American Steam Gauge & Valve Mfg. Co Boston, Mass.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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B. F. Sturtevant Co., Boston, Mass.

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H. Mueller Mfg. Co., Ltd., Sarnia.

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Penberthy Injector Co. Windsor, Ont

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Engineering and Machine Works of Can Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont
MacGovern & Co., Inc., Montreal, Que

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Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Lamie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
B. F. Sturtevant Co., Boston, Mass.

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Crane Ltd., Montreal
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Lunkenheimer Co., Cincinnati, Ohio.

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Dart Union Company, Ltd., Toronto, Ont

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto
H. Mueller Mfg. Co., Ltd Sarnia
Homestead Valve Mfg. Co., Pittsburg
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd. Ottawa.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

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H. Mueller Mfg. Co., Ltd., Sarnia.
Jas. Morrison Brass Mfg. Co., Toronto
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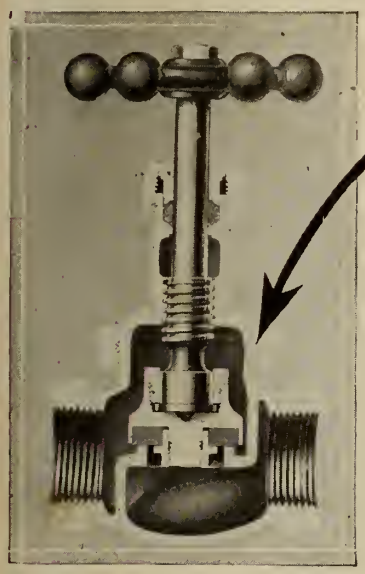

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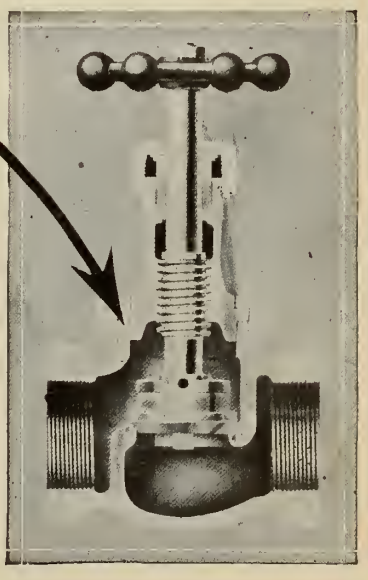

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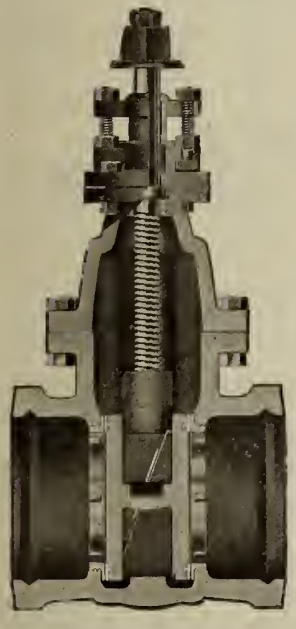

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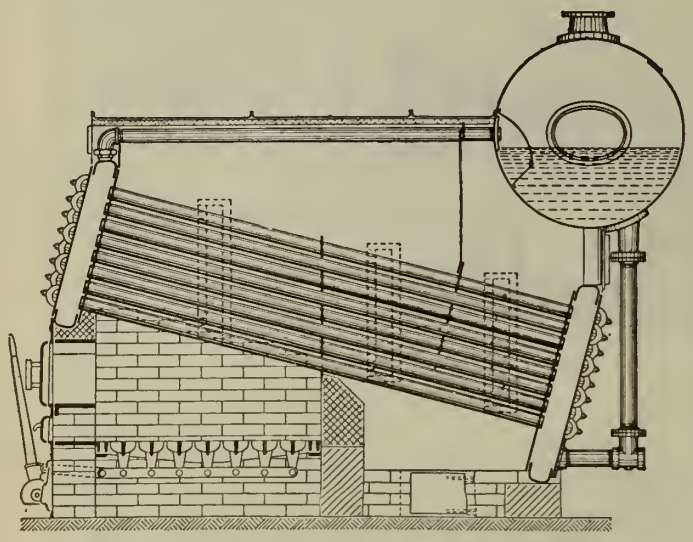

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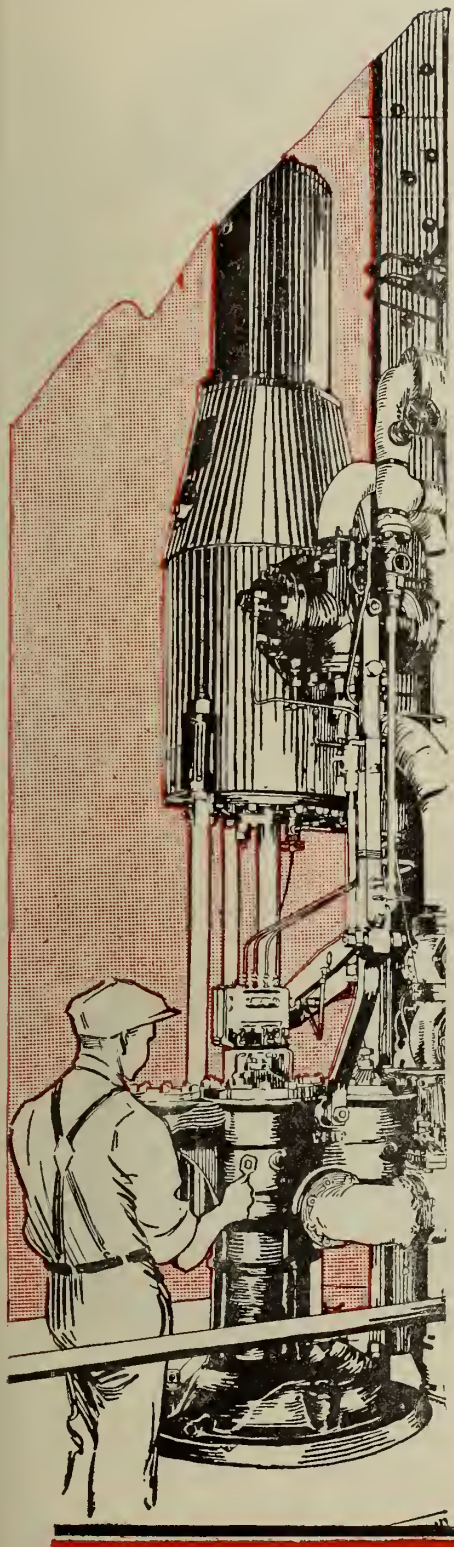

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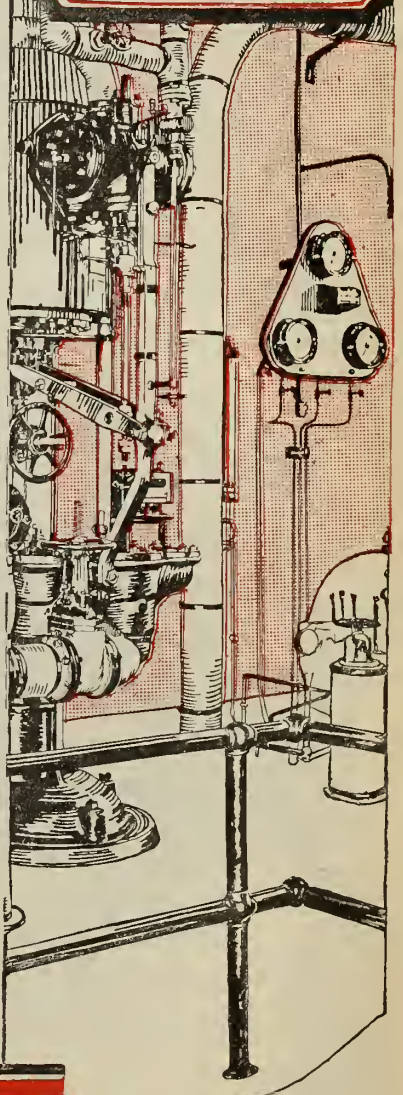

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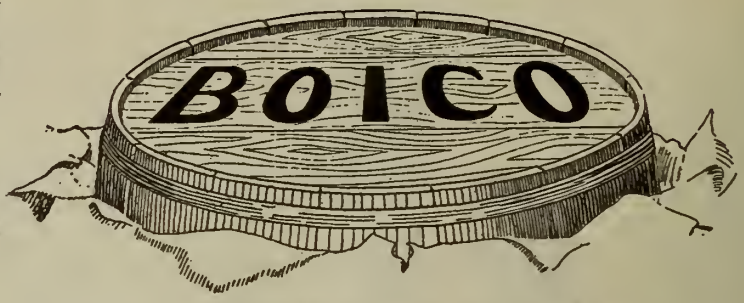

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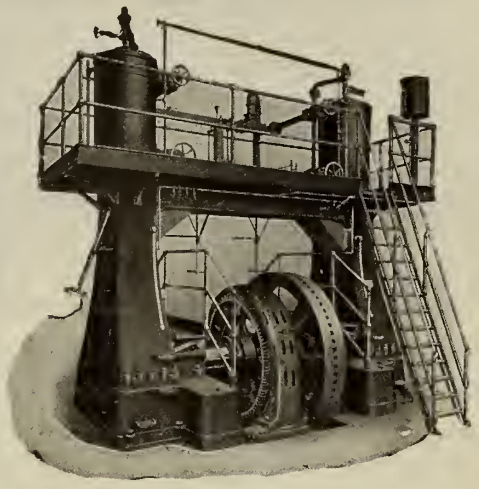

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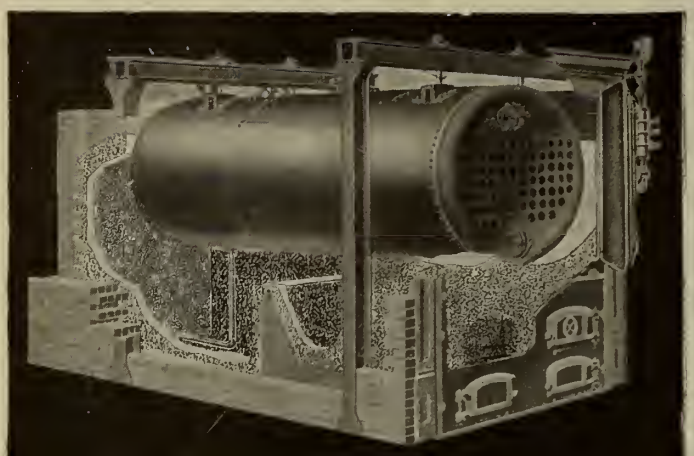
PAGE-HERSEY TUBES, LIMITED

Head Office: 100 CHURCH STREET, TORONTO, ONT.



SMILES AT HIGH HEAT

Boiler furnace linings moulded into place, forming a solid, one-piece monolithic lining will withstand the variations and extremes of heat under continuous service, when the proper lining material is used viz:—

BETSON'S

REG. U.S. TRADE MARK PAT. OFF. PLASTIC FIRE BRICK

The result of twenty years of scientific and practical experience. Only those refractory materials that are of tested quality and purpose are used, and these years of experience have produced a most generally satisfactory lining material. Not theoretically but under actual everyday conditions.

There is only ONE Plastic Fire Brick and it comes to you in barrels in a moist, plastic condition, ready for use. Any intelligent person can do the work, no special tools, forms or skill is required.

Costs less than fire brick or special blocks, is always available and will outlast other linings.

Keep a barrel on hand for emergency repairs if not ready to re-line.

Write for booklet—it is full of valuable information.

Betson Plastic Fire Brick Co.
Inc

P. O. Box 386-6
ROME, N.Y.

Canadian Distributors:
International Chemical Co.
44-46 Lombard St.
Toronto, Ont., Canada

Shipment F.O.B. nearest warehouse in our new substantial "Yellow-Top" barrel.

Mr. Engineer, are you--

one of those wide-awake, up-to-the-minute engineers who is willing to be shown how economies can be effected in the boiler room? Many power plants in Canada and the United States, especially noted for high operating efficiency, consider "Bailey" meters essential to the best operation of either coal or oil-fired furnaces.

Bailey Boiler Meters

"Bailey" Boiler Meters—the coal savers—record the true relation between the coal and air supply to the furnace and plainly show the men what adjustments to either are required to maintain high operating efficiency and economy.

CHARTS SHOW PERFORMANCE OF INDIVIDUAL BOILERS

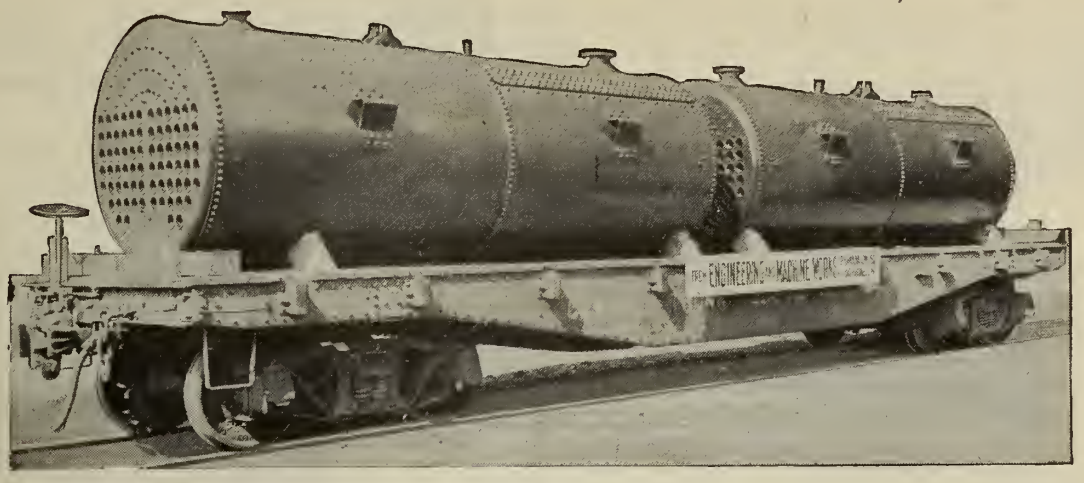
and tell when a boiler requires cleaning or inspection for leaky tubes or broken baffles. You can check the work of the fireman at all times.

Try one "Bailey" Boiler Meter and you will soon order "Bailey" equipment for all of your boilers.

May we send full details? Tell us your requirements.

COAL SAVERS

Bailey Meter Co.
2001 E. 46th St.
CLEVELAND,
OHIO



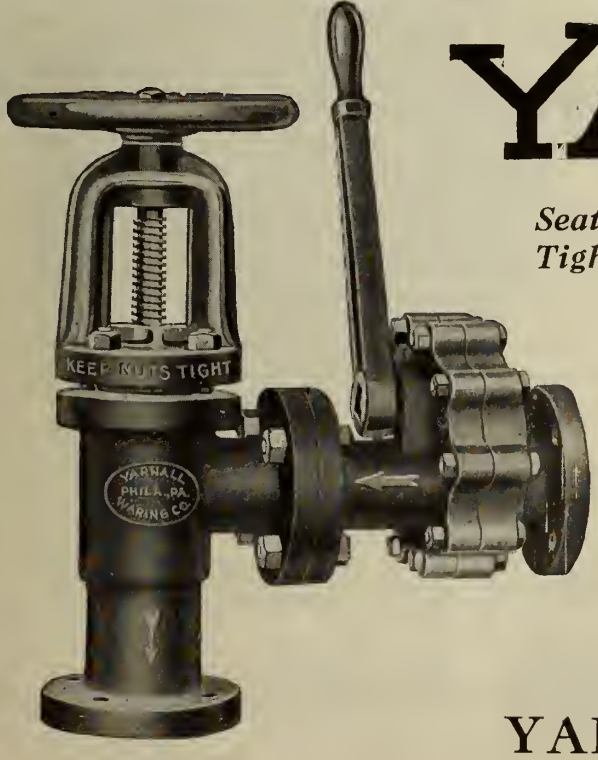
The Orders for New Boilers we are Getting-

Showing a real improvement over the past few months, also show that wide-awake firms are planning to improve and enlarge their steam plants now. We can give you prompt deliveries of Boilers—any type—any size. Steel plate work of all kinds. Grey Iron Castings. Get our prices—they will please you.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices :
HALL MACHINERY CO. Sherbrooke, Que., and Birks Bldg., Montreal



YARWAY

Seatless Blow-off Valve and Double-Tightening Valve in Tandem Arrangement

A combination first developed to meet A. S. M. E. boiler code and boiler laws in certain states—that is ideal for blow-off service in any state.

The Yarway Blow-Off Valve is a slow opening, seatless valve that does away with the seat troubles of the old type valves and that automatically tightens the packing after the valve itself has closed, and releases the packing before valve starts to open.

The Yarway Double-Tightening Valve is a quick opening valve with the unique feature of a sealing bushing on the inlet side which makes the valve double tightening on both sides of the swing gate.

With both valves in place the blow-off line is doubly guarded. Highly successful installations of this type are numerous. B-410 is a handy booklet that will show you the unusual features of the Yarway Valves in detail. To whom shall we mail it?

YARNALL - WARING CO.

7604-20 Queen St. Chestnut Hill, Philadelphia

For complete list of offices see Sweet's Engineering Catalog, Keystone Mining Catalog, Sterling Marine Catalog or Chemical Catalog.

Also Makers of

Yarway-Lea V-Notch Meter
Yarway Hydraulic Valve
Yarway Pipe-Joint Clamp
Yarway Boiler Skimmer
Yarway Unloader
Yarway Adjustable Spray Head
Yarway Holtite Pipe Clamp

IT PAYS!

It means money in your pocket to line your furnaces with

PLIBRICO JOINTLESS

FURNACE LINING

A perfectly air-tight, gas-tight furnace lining, such as is yours when baffles, side walls, bridge walls, and front door arches are constructed of PLIBRICO, gives you many opportunities to save.

You save fuel, for in jointless PLIBRICO there is no chance for costly heat units to escape. You need pay only for the fuel you burn.

You save time, for there are no shutdowns for repairs when PLIBRICO has been properly installed and vitrified.

You save labor, for any man about the plant, who can wield mallet and trowel, can install PLIBRICO settings.

Let us tell you more about PLIBRICO. Write for our book L-36 on "Modern Furnace Building."

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

CANADIAN DISTRIBUTORS:—Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto Ont.; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Clancey & Grindley, Calgary, Alta.

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

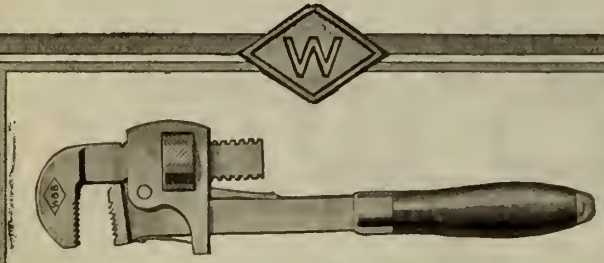
All **Made to Gauge. All parts interchangeable.** Give us opportunity to figure on your pumping requirements.

Fig. 7284

We have full line of Patterns for direct acting steam pumps and belted or direct connected power pumps.

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.



Williams' Stillson Wrenches

Are sturdy and dependable—well balanced—positive in grip—powerful in action.

The tough teeth retain their sharpness; they "bite" instantly, yet release readily.

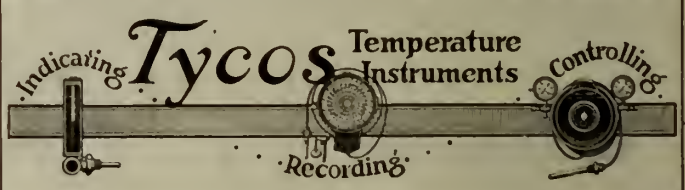
Wood and Steel Handle Patterns – eight sizes, 6 to 48 inches. Ask for booklet.

J. H. Williams & Co.
LIMITED

"The Wrench People"

Formerly Canadian Branch of The Whitman & Barnes Mfg. Co.

78 Thorold Road - St. Catharines, Ont.



Our seven decades of experience—combining highest engineering talent, modern and well organized facilities in solving of temperature problems—make unusual economies immediately and permanently available in your plant.

Our service at your disposal.

All Makes of Temperature Instruments Now Repaired in Canada.

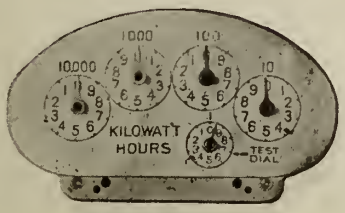
Taylor Instrument Companies

110-112 Church St., Toronto Ont.

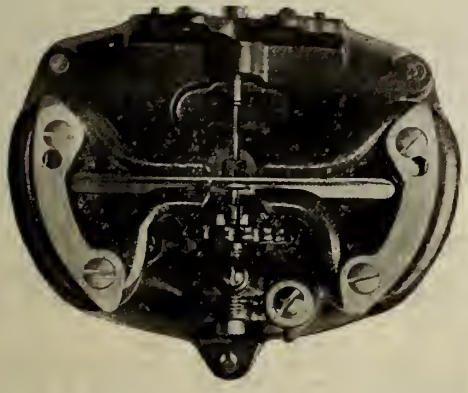
There's a Tycos and Taylor Thermometer for Every Purpose

750½

SANGAMO WATT HOUR METERS

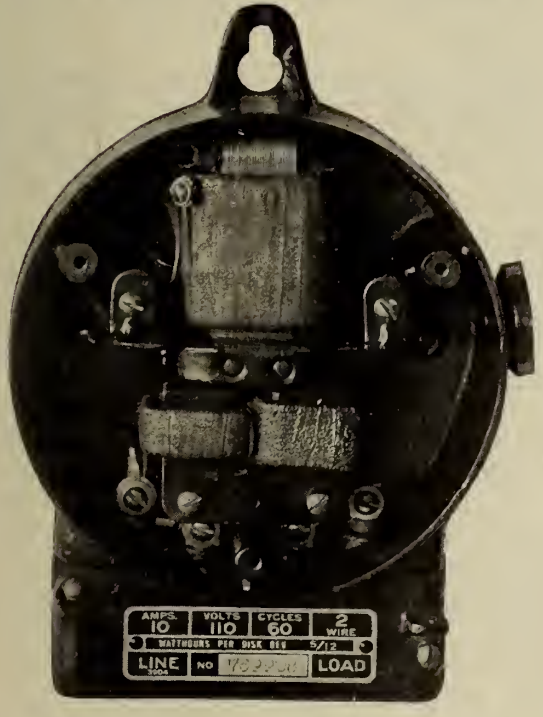


Accuracy, Permanency Simplicity of Adjustment



The Potential Coil is built on the core and is removed and replaced as a unit.

The Current and Potential Coils can be changed without dismantling the moving element.



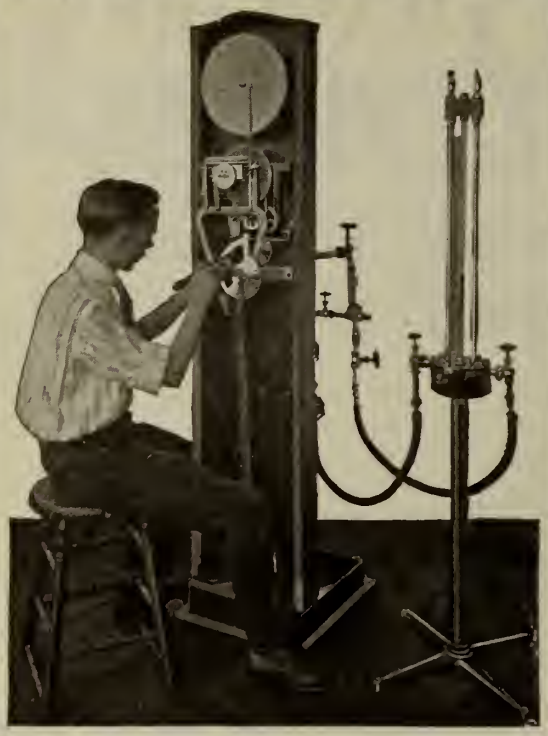
As all parts are dowelled and accurately made, faulty assembly or variations in the air gap is impossible.

Both the full load and light load adjustment are controlled by graduated screws, easily accessible when the meter cover is removed.

Write Our Nearest House for Descriptive Literature.

Northern Electric Company
LIMITED

Montreal Halifax Quebec — Ottawa Toronto Hamilton — London — Windsor Winnipeg Regina — Calgary Edmonton Vancouver



The Rugged Register

48-Hour Test Before Shipment

Because the VENTURI METER TUBE affords a high differential pressure at the inlet and throat it permits the use of an unusually rugged registering device, which also indicates the momentary rate of flow on a 12-inch dial and records the rate of flow on a circular chart.

VENTURI METER

Registers are, however, none the less accurate because they are rugged. They respond instantly to minute changes in the rate of flow and operate with a high degree of accuracy. This is because the readings from each device are tested before shipment by comparing them with the indications of a Single Tube Manometer. The Register also undergoes a hydrostatic pressure test of 300lbs. per square inch for 24 hours. Minor faults are corrected by experienced workmen and defective parts are replaced. The entire test covers a period of 48 hours.

Literature describing the VENTURI for measuring hot or cold water, sewage, brine, chemical solution, oil, gas, air or steam, will be sent on request.

BUILDERS IRON FOUNDRY
"Builders of the Venturi"
Providence, Rhode Island

Canadian Representatives:
GENERAL SUPPLY CO. of CANADA, LTD.
Ottawa Montreal Winnipeg Vancouver
ALLEN GENERAL SUPPLIES, Limited
TORONTO, ONTARIO

De Laval velocity-stage turbine driving blower in gas plant; 5,000 cu. ft. of free air per min. against 35 in. water column, at 4,800 r.p.m.

Gas Blowers
Have Hard Service

BUT **De Laval Turbine-Driven Gas Blower Units** are exceptionally substantial and reliable. Powerful and efficient governors give accurate speed regulation; bearings are supplied with forced lubrication; the wheels and shafts are made of high-grade alloy steels; the shafts are extra large; bed plates, casings and pedestals are extra heavy; in fact, every precaution has been taken to insure continuous, satisfactory operation. Economy is also provided for, the turbines being fitted with hand-operated nozzle valves so that high efficiency can be maintained with considerable variations in load and steam pressure.

De Laval

Steam Turbine Co.

Turbine Equipment Co., 73 King St. W, Toronto.
The Laurie Company, Bleury St., Montreal.
Taylor Engineering Co., Ltd., Vancouver.

DELAYS ARE DANGEROUS!

Don't delay having your floors re-laid until your plant is running at full capacity.

Prepare for good, normal times NOW by having Reed "SPECIAL" Mill Floors laid in your plant.

These "SPECIALS" are winners—they're absolutely damp and rot proof and are built to withstand the constant jar and vibration of heavy machinery.

We've been building floors for seventy years, and have **earned** our reputation as "Builders of Good Floors."

We also specialize in Power House and Factory Roofs.

Our Ventilating, Roofing and Flooring Engineers will be glad to co-operate with you. Write us.

KEEP CANADA BUSY

GEO. W. REED & CO., LIMITED
MONTREAL

KEEP YOUR BOILERS CLEAN
TO SAVE FUEL

⅛-inch Deposit on Tubes Increases Coal Consumption 30%
¼-inch Deposit on Tubes Increases Coal Consumption 66%
½-inch Deposit on Tubes Increases Coal Consumption 150%

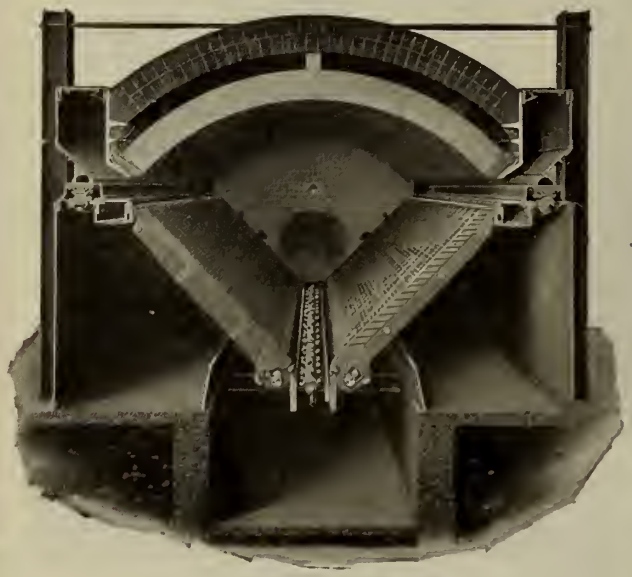
MILLER'S
BOILER CLEANING EXTRACT

Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

TRY A CASK!

R. C. Miller Oil & Supply Company
38-40 Youville Square, MONTREAL

MURPHY AUTOMATIC FURNACES



Spending to Save

To-day you are vitally interested in reducing production costs. Is your power plant one of the many using hand-firing methods for boilers from 50 H.P. up to 300 or 400 H.P.? If so, you have an opportunity you cannot afford to overlook.

Investigate Murphy Automatic Furnaces and you will learn how thousands of satisfied users all over the country have made a saving of 15 to 30 per cent. on their coal bill—at the same time eliminating black smoke.

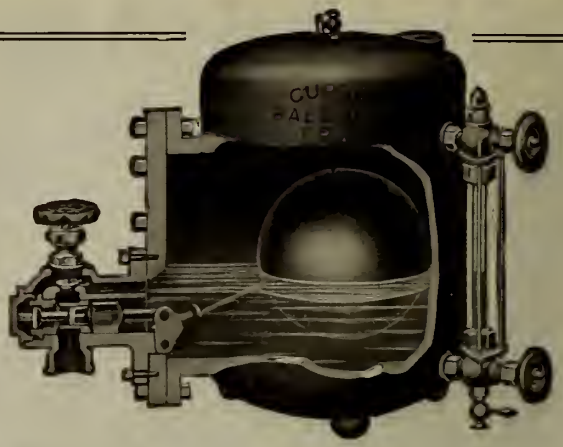
Spending money now to save money by reduced costs is not extravagance—it is sound, common sense.

Murphy Furnaces can be installed under any type of boiler from 50 H.P. up. Ask us to send you our Catalog HM-3.

For information on RILEY UNDERFEED STOKERS for large boilers, see last month's advertisement or send for RILEY STOKER Catalogue H R-3

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The vaive can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1921 Catalog of Curtis Engineering Specialties. Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: { 180 Washington St., New York City
{ 174 N. Market St., Chicago, Ill.

Feed Regulation Planned Scientifically

Every boiler plant presents its own problem in boiler feeding. To meet specific operating characteristics with assured efficiency requires careful study of the conditions on hand before the proper automatic feed regulation can be applied.

COPES BOILER FEED REGULATORS

Each Copes is designed for the specific conditions governing the boiler—the control valve is neither too large nor too small. This insures maximum efficiency. Finally, the guiding force of the Copes is great in proportion to the internal resistance of the regulator, so as to insure smooth and continuous opening of the regulating valve and not a "step by step" motion.

Northern Equipment Co.

112 West 11th Street, Erie, Penn.

Branch plants

Hamilton, Ontario, Canada.
Manchester, England. Paris, France.
Cologne, Germany.

LUNKENHEIMER

Valves and Engineering Appliances

VALVES, of Bronze, Iron or Steel for lines carrying Steam, Liquids or Gases.
Globe, Angle and Cross; Gate Check, Throttle, Safety, Non-return Stop, Pop Safety, Relief, Blow-off, etc.

BOILER MOUNTINGS,
Water Columns, Water Gauges and Gauge Cocks, Fusible Low Water Alarms, Injectors Whistles, Etc.

LUBRICATORS, for Steam, Gas, Gasoline and Oil Engine and Air Compressor Cylinders.

LUBRICATING PUMPS, Hand and Mechanically Operated.

OIL CUPS, Glass or Bronze Body, with or without Sightfeed.

GREASE CUPS of Bronze, Iron or Steel with Automatic or Screw Feed, Etc.

With a record of more than fifty-eight years of success LUNKENHEIMER Valves and Engineering Appliances offer the user a service unequalled.

The name LUNKENHEIMER is a guarantee for safety, service and satisfaction, because by the LUNKENHEIMER method of manufacture, a perfect knowledge of the condition and actual performance of an appliance is had before it leaves the factory.

There is a type and size for every purpose and the LUNKENHEIMER Distributor in your locality carries a stock for immediate delivery. By acquainting him with the conditions of operation in your plant he will be enabled to anticipate your requirements, give prompt service and prevent delay and a possible shut down when an emergency arises.

Specify LUNKENHEIMER and insist on getting what you specify.

Write for Catalog 58-DC

THE LUNKENHEIMER CO.
"QUALITY"

LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD

NEW YORK CHICAGO CINCINNATI BOSTON LONDON

EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

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Piping for Economy and Efficiency in Steam Plants

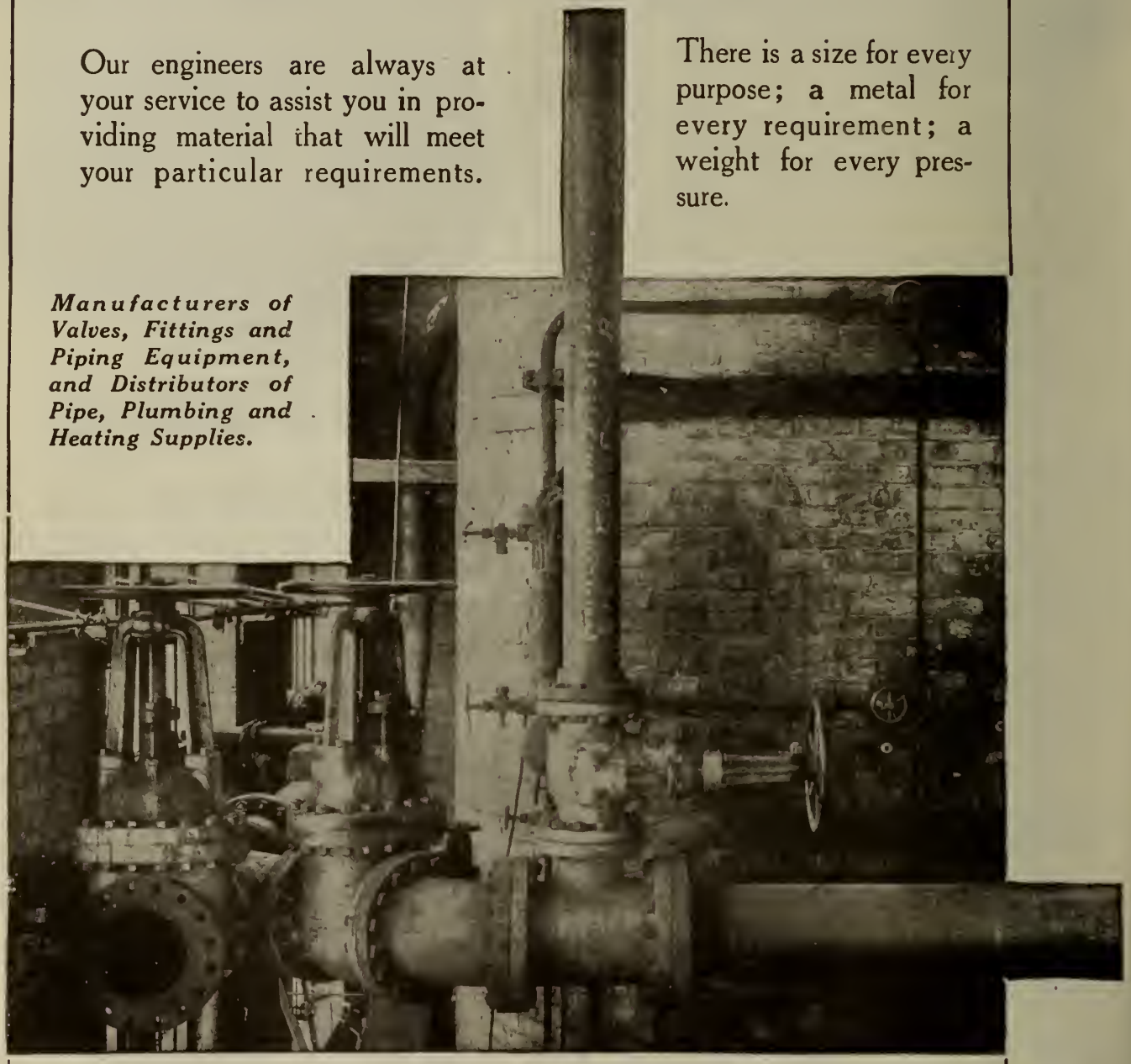
is largely facilitated by the use of

CRANE
VALVES, FITTINGS STEAM SPECIALTIES

Our engineers are always at your service to assist you in providing material that will meet your particular requirements.

There is a size for every purpose; a metal for every requirement; a weight for every pressure.

Manufacturers of Valves, Fittings and Piping Equipment, and Distributors of Pipe, Plumbing and Heating Supplies.



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LIMITED
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1280 ST PATRICK STREET
MONTREAL

Branches and Warehouses:
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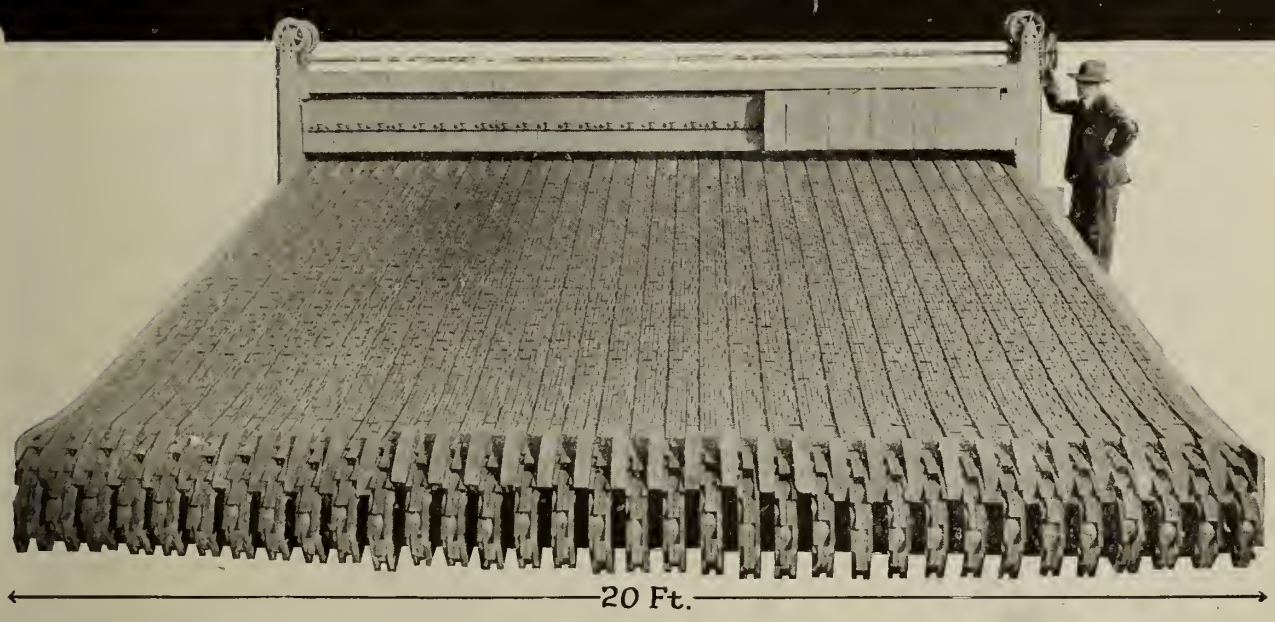
26

Largest Conveyor Feed Stoker Ever Built!



Pictured above is a 1200 H. P. STOWE STOKER—the largest single unit ever built on the conveyor feed principle. This stoker was designed to develop 300% of rating, and is now installed in the plant of the Central Illinois Light Co., Peoria, Ill., where it is giving excellent service.

You can get a single STOWE STOKER in sizes up to 1500 H. P. Think of being able to supply your 1500 H. P. Boiler with a forced-draft, conveyor-feed stoker in *one* large unit!

It means doing away entirely with the high maintenance of a center wall, which fills up furnace space and necessitates two stokers to a boiler.

The STOWE STOKER is a *forced-draft* type whose fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit. It is the last word in massive, durable and efficient construction.

When one considers first, the many striking features and advantages of the STOWE STOKER, and then, the marked simplicity of this mechanism, the realization comes that here is a truly great *achievement* in mechanical equipment design. Better write for the details.

We also manufacture The L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices: Chicago, 1366 Peoples Gas Bldg. New York, 504, 50 E. 42nd St. Pittsburgh, 901 Oliver Bldg.

E157

LACLEDE-CHRISTY

A BUSINESS INSTITUTION — FOUNDED 1844 **ST. LOUIS**

Aeroplane View of the Berliner Gramophone Company's Plant, St. Henry, Montreal.

"His Master's Voice" People use Jenkins Valves

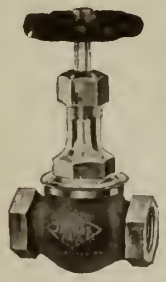


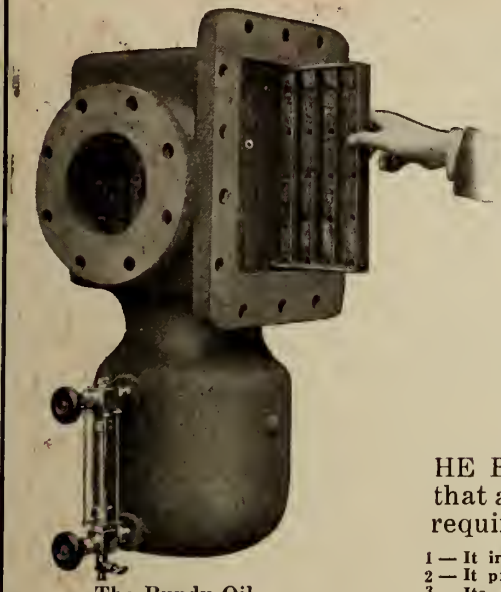
Fig. 106
Jenkins Brass Globe Valve
Standard Pattern

Successful manufacturers like the Berliner Gramophone Company realize the importance of dependable equipment at every point and, naturally, "Jenkins" is the choice wherever valves are used.

Many years ago Jenkins Valves were installed in the original Berliner plant and functioned so satisfactorily that the Company insisted upon similar valve equipment in the big new factory addition recently completed.

Jenkins Valves are sold by supply houses everywhere. Know the genuine by the Jenkins name within a Diamond Mark Cast on the body.

Jenkins Bros.
LIMITED
TRADE JENKINS MARK
Jenkins Bros
Head Office and Works: 103 St. Remi St. Montreal Can.
TORONTO
European Branch
6 Great Queen St., Kingsway, London, W.C.2. Eng.
VANCOUVER
AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD
TRADE JENKINS MARK
Jenkins Bros



The Bundy Oil Separator

SEPARATORS!

Why most engineers choose the—

BUNDY for Oil

and the

STRATTON for Water

The New Stratton Separator.

HE BUNDY Oil Separator is the **only** type that actually meets in practice the **three** vital requirements of an oil Separator.

1 — It insures maximum removal of oil from steam.
2 — It prevents steam from again picking up oil.
3 — Its separating efficiency is always maintained because it is easily cleaned.

The STRATTON Separator is of the centrifugal type. It thoroughly eliminates moisture without adding back pressure. Well known among engineers for its simplicity, large receiver capacity and high efficiency.

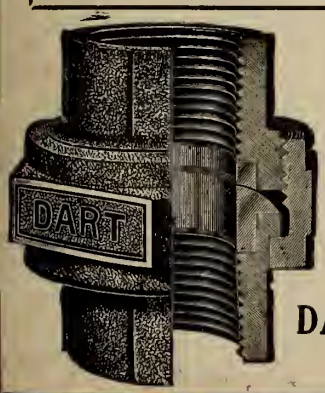
The Mason Regulator & Engineering Company, Limited
Head Office and Works: 135-153 Dagenais St., Montreal, Que.
Agencies or Branches at: TORONTO, HALIFAX, ST. JOHN, WINNIPEG and Vancouver.

See that

smooth-ground, bronze-to-bronze, ball-joint?

This joint makes leakages impossible because it cannot rust or corrode under any circumstances.

Can be Used When Pipe is Out of Line, and Will Not Leak. That's a "Dart" Feature.



DART UNION CO., Ltd., TORONTO

Ask Your Jobber. He Handles Them.

Stoker

Five Months of Steady Overloads—

Boilers in this plant were kept on line continuously for five months at 150% to 250% of rating. Name on request.

Three Months Continuously—Peak Loads at 340%

Such is the operating record of this "A-C." equipped plant. Name furnished on request.

Three Months of Continuous High Capacity

Boilers were kept on line continuously for over three months. Loads varied from 75 per cent. of boiler rating to 250 per cent. Name furnished if requested.

Service that Costs Less Per Year

Most plant owners and operators know that mechanical stokers are to-day a necessity from the standpoint of economy. Of course the stoker that gives lowest cost service is the stoker these power users want.

An investigation of the operating records of Jones equipped plants will convince them that Jones Stokers *do* give lowest cost service;

—that when the immense saving of these stokers is considered, first cost *is* lower.

—that because of their rugged simplicity—unequalled by any other multiple retort stoker—maintenance costs *are* lower.

—that their ability to meet high peak loads and heavy overloads, and maintain overloads constantly—confirmed by the plant records opposite—*does* mean still greater saving.

—that the saving of labor because of the ease of manipulation *is* greater.

—that the under-feed principle, as enhanced by improvements and refinements in Jones design, *does* mean greater economy in burning Canadian coals.

Jones Stokers are made in two types: Jones "AC" (Automatic-cleaning) Stoker for highest-duty requirements, and Jones "Standard" Stokers for a wide range of service.

Jones engineers will investigate your plant conditions and advise the type best suited to your own plant conditions.

JONES STOKERS are made in Canada by Canadian and sold for Canadian money. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized, and the new organization makes available for Canadian power users the resources and engineering resources of the Under-Feed Stoker Co. of America.

The Under-Feed Stoker Co. of Canada, Limited

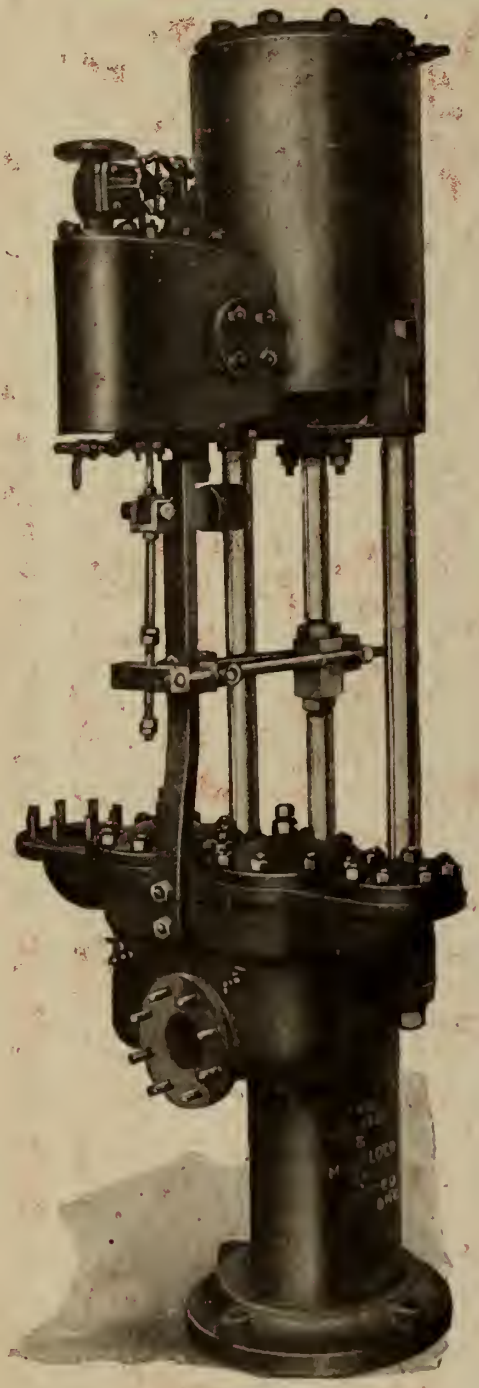
81 VICTORIA STREET - TORONTO

Quebec and the Maritime Provinces:
THE CLEATON CO. (CANADA), LTD.
303 Southam Bldg., Montreal

Alberta and Saskatchewan:
MR. J. TWOMEY, Camrose, Alta.

British Columbia:
E. A. EARLE, LIMITED
739 Hastings St. W., Vancouver, B.C.

Jones Stokers



G. & McC. Co. Vertical Simplex Boiler Feed PUMPS

Modern Boiler Room Requirements

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Efficiency Tests of a 30,000 k. w. Turbine

The Power Plant of the Interborough Rapid Transit Company, New York, Contains Three of These Units. The Turbines are of the Curtis Impulse Type, Having Twenty Pressure Stages

By HERBERT B. REYNOLDS, New York, N. Y.

IN order to provide additional power capacity for the new subways constructed in New York City during the period from 1913 to 1921, and operated by the Interborough Rapid Transit Company, additional turbine units were installed in both the 59th Street power stations. The three 30,000-kw. Westinghouse cross-compound turbines which were completed in 1915 were among the new units installed at the 74th Street Power Station. The results of the tests upon these turbines were presented before the Society by H. G. Scott and W. S. Finlay, Jr., in 1916.

At the 59th Street Power Station, the installation of three 30,000-kw. General Electric turbines has been completed within the past year. Very complete tests have been conducted upon these added units, the results of which are set forth on the following pages.

Reviewing briefly the history of the developments at the 59th Street Power Station, it will be recalled that the original engine-room equipment consisted of nine 7500-kw. maximum-capacity Manhattan type Allis-Chalmers double angle compound engine units, and three Westinghouse 1250-kw. turbines, the latter driving 60-cycle generators which supplied 60-cycle current for subway lighting. The use of this current for lighting was subsequently discontinued and in its place 25-cycle current is now used which is taken from the main units. During 1909 and 1910, five low-pressure 7500-kw. maximum-capacity General Electric turbine units were added, taking exhaust steam from five of the engines at atmospheric pressure. A description of these units and a full report of the tests which were conducted on them are given in a paper presented by H. G. Scott and R. J. S. Pigott before the Society in 1910. The units most recently installed in the 59th Street Power Station are the three 30,000-kw. General Electric turbines mentioned above.

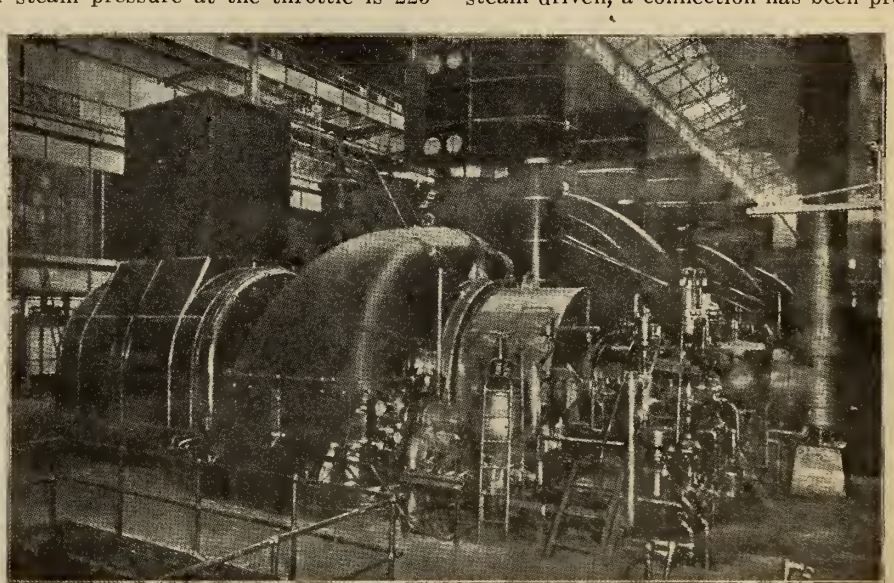
The Turbine Units

Two of the 30,000-kw. units, Nos. 7 and 8, were installed in the space formerly occupied by the three lighting units mentioned in the preceding paragraph, while the third turbine, unit No. 12, see Fig. 1, was installed at the western end of the station. The great concentration of power possible with modern turbines is strikingly shown by the space they require as compared with that for reciprocating engines. The maximum capacity of the engines which are visible in the figure is but 2625-kw. while that of the turbine in the foreground is 35,000-kw.

The general arrangement of unit No. 12, upon which the tests were conducted is shown in Fig. 2, The turbines are of the straight Curtis impulse type, having twenty pressure stages, each pressure stage consisting of one velocity stage. Fig. 1 is a close view of the governor end of the turbine and shows the auxiliary oil pump, etc. The normal steam pressure at the throttle is 225 lbs. per square inch abs. with a superheat of 150 degrees Fahr. exhausting into a vacuum of 29 inches Hg. referred to a 30 inch barometer at 58.1 degrees Fahr. The speed is 1500 r.p.m. In addition to the primary steam inlet, a secondary valve is provided which opens after the load reaches 24,000 kw. and which enables the turbine to carry a load of 35,000 kw. The generator is designed so that this load can be carried continuously.

Water sealed glands are used which obtain their water supply from the condensate discharge. A self-contained lubricating system is provided. The oil is circulated through the coolers and bearings by means of a pump driven from the turbine shaft. For starting up and emergency purposes a separate pump is provided which is driven by a small steam turbine, the speed of which is automatically controlled by the oil pressure. In addition to the cooling effect of the oil, the bearings are further cooled by the circulation of condensate through the water jackets.

As all auxiliaries in the station are steam driven, a connection has been pro-



One of the 30,000 K.W. Turbines installed in 1920.

1 Mechanical Research Engineer, Motive Power Dept., Interborough Rapid Transit Co.

Paper presented at the Spring meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

1 Trans. Am. Soc., vol. 38, page 655.

2 Trans. Am. Soc. M. E., vol. 32, page 69.

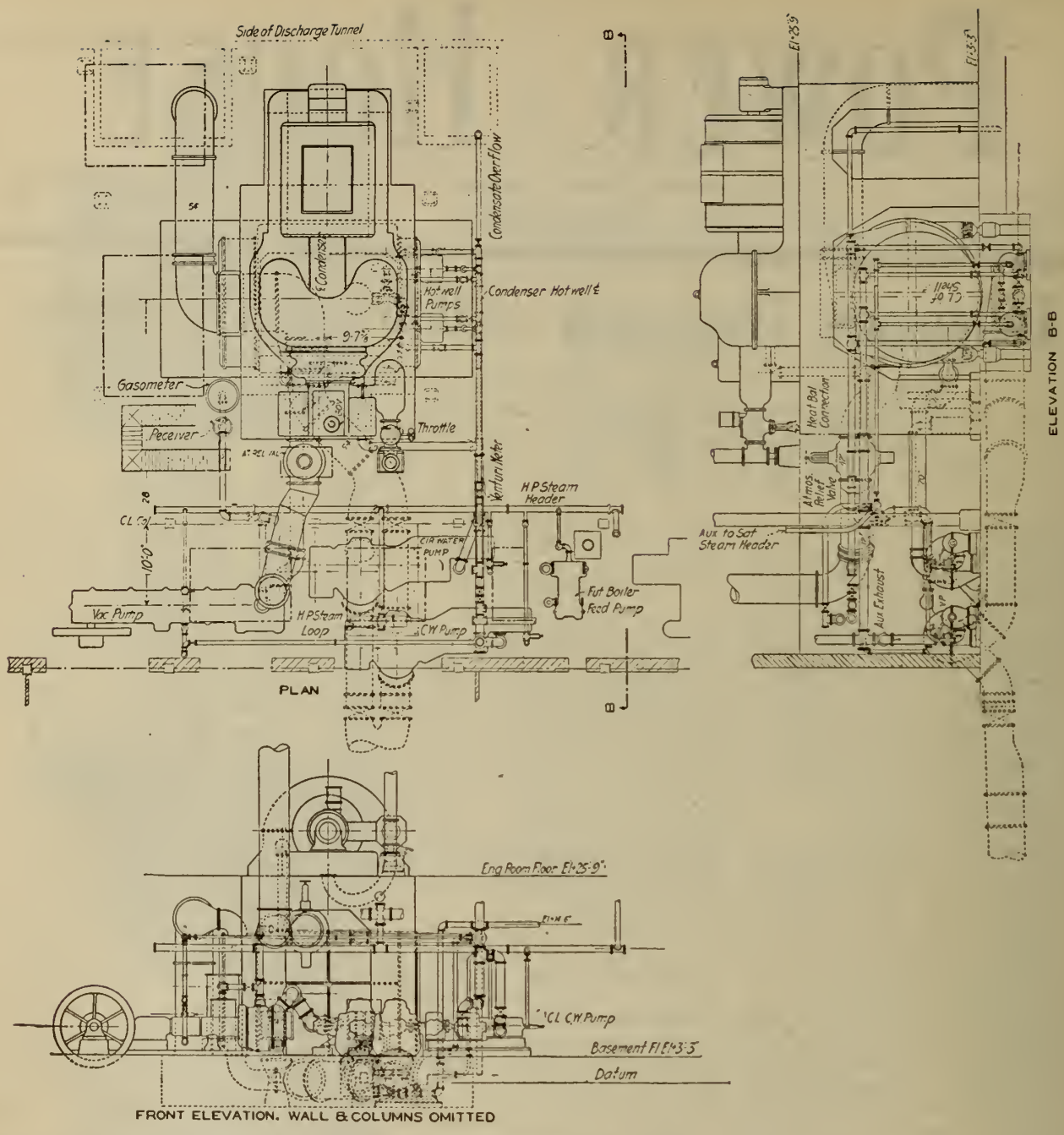


Fig. 2.—General Arrangement of Unit No 2

vided in the turbine through which any excess auxiliary steam may be injected. This connection is at the 16th stage of the turbine.

The generators are three-phase, star-connected, generating 25 cycle current at 11,000 volts. Excitation current is furnished at 250 volts. The generators are cooled by a circulation of air maintained by a fan which forms an integral part of the generator. The air is drawn from the turbine room basement and discharged from the top of the generator into the turbine room through a short stack which may be seen in Fig. 1.

Condensors and Auxiliaries

The condensing equipment for each unit consists of one single shell two-pass Worthington condensor, two Worthington centrifugal circulating pumps each driven through reduction gears by Kerr turbines, two Worthington centrifugal condensate pumps each driven by a General Electric turbine, one Laidlaw-Dunn-Gordon dry vacuum pump. The general arrangement of the condensing equipment is shown in Fig. 2.

Each condensor contains 50,000 sq. ft. of tube surface made up of 1,076 tubes 18 ft. long, 1 in. outside diameter and of No. 18 B.W.G. thickness. The condensor is of the two pass type, the water entering the bottom and passing out from the top. As the condensors are mounted on springs, rubber expansion joints are inserted in the circulating water lines.

Each circulating water pump is capable of delivering 30,000 gal. of water per min. against a total head of 37 feet. The turbines which drive these pumps operate at 3950 r. p. m. This speed is reduced to 395 r. p. m. through Kerr reduction gears. The impellers are made of bronze and are of the enclosed or shrouded design. Each condensate pump is capable of delivering 950 gal. per minute against a head of 60 feet. The turbine and pump both operate at a speed of 1500 r.p.m. The dry vacuum pumps are of the single rolling mill frame two-stage rotative type with poppet valve steam cylinder and two-stage water-jacketed vacuum cylinder.

Foundations

Two of the units No. 7 and 8 were installed on the foundations which formerly carried the three 1250 kw. 60-cycle lighting units mentioned earlier. However it was necessary to alter these foundations to some extent in order to receive the new turbines. The third turbine No. 12, was installed on new structural steel foundations encased in concrete.

As no expansion joint was provided

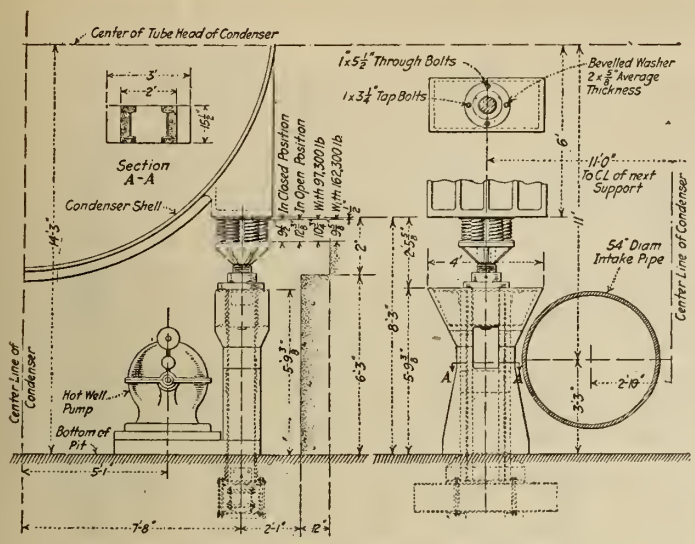

Center of Tube Head of Condenser
1"x5½" Through Bolts
1"x3¼" Tap Bolts
Bevelled Washer 2"x⅝" Average Thickness
Section A-A
Condenser Shell
In Closed Position With 97,300 lb
In Open Position With 162,300 lb
11'0" To CL of next Support
54" Diam Intake Pipe
Center Line of Condenser
Center Line of Condenser
Hot Well Pump
Bottom of Pit

Fig. 3.—Spring Supports for Condenser

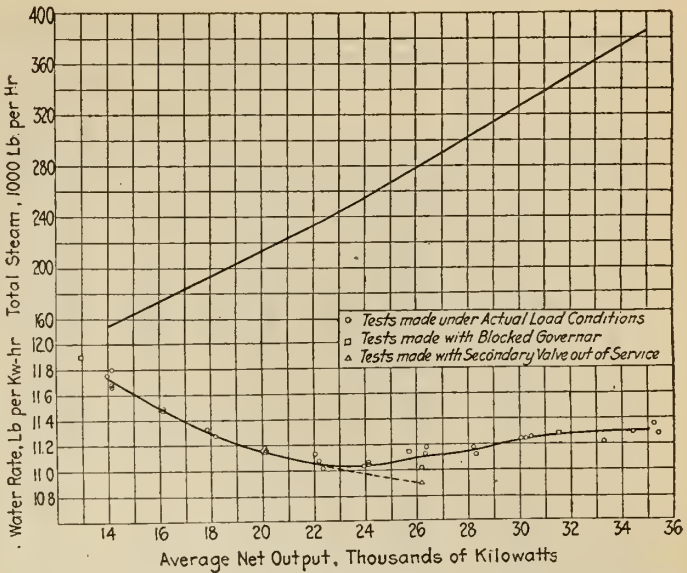

Water Rate, Lb per Kw-hr Total Steam, 1000 Lb per Hr
Average Net Output, Thousands of Kilowatts
Tests made under Actual Load Conditions
Tests made with Blocked Governor
Tests made with Secondary Valve out of Service

Fig. 4.—Water Rate Curve and Williams Line for 30000 K.W. Turbine. Steam press. 225 lbs. abs. superheat 150 deg F. Vac. 29 in Hg. referred to 30 in bar. Curve based on tests Nos. 10 to 14.

between the turbine and condensor, it was necessary to mount the condensor on spring supports so as to take care of expansion and contraction. These spring supports are shown in Fig. 3.

In order to facilitate the setting of these springs and also provide a means of detecting and adjusting for any fatigue which might occur in them, hyraulic jacks were incorporated in the condenser supports as shown of the turbine outlet and the face of the condenser inlet. The load on each of the four supports was then determined by noting the oil pressure on the jacks. It was decided that with the condenser empty and cold, the ownward pull on the turbine should not be less than approximately 17 tons. The distance that the joint between turbine and condensor would have to be pulled in order to give this load was estimated sure required to just raise the lock-nuts. Every few months the load carried by the springs will be determined in this manner and compared with the load which existed when the condenser was first bolted to the turbine. Any fatigue which may develop in the springs will be compensated for by screwing the lock nuts down.

It was found that the minimum condenser load carried by the turbine with

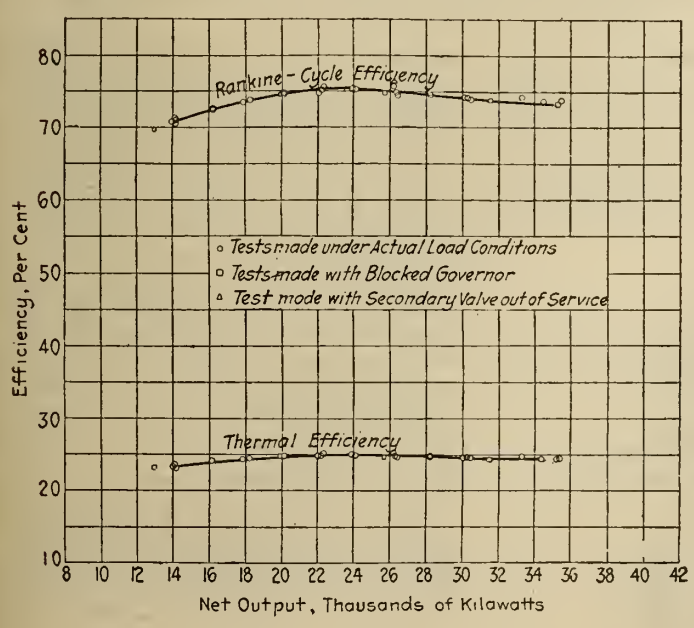

Rankine-Cycle Efficiency
Thermal Efficiency
Efficiency, Per Cent
Net Output, Thousands of Kilowatts
Tests made under Actual Load Conditions
Tests made with Blocked Governor
Test mode with Secondary Valve out of Service

Fig. 5.—Rankine Cycle and Thermal Efficiency Curves for 30000 K W. turbine. Steam Pressure 225 lbs. abs. superheat 150 degrees F. Vacuum 29 ins. Hg. referred to 30 in. bar. Curves based on tests 10 to 44 inclusive

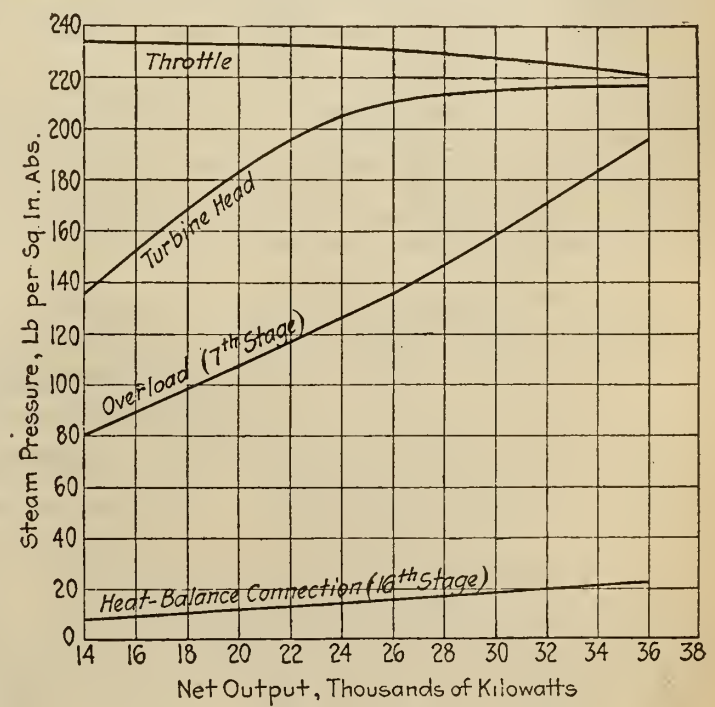


Fig. 6.—Variation of Steam Pressure with the load at various points throughout the turbine.

in Fig. 3 As the procedure followed in setting these springs may be of general interest a brief description will be given. After the erection of the condenser and circulating water pipe had been completed, with the exception of making the joint between the condenser and turbine, the condenser was raised while empty, by means of jacks, leaving 3/8 inches clearance between the face from the modulus of elasticity of the turbine and condenser metal. The condenser was then raised to within the predetermined distance of the turbine outlet, which was found to be .231 in. after which the lock nuts on the jacks were screwed home and the condenser bolted to the turbine. The load on the springs was then determined with the condenser still empty by noting the pres- the condenser shell empty was approximately 17 tons, which checked with the established minimum. As the water required to fill the condenser amounts to approximately 60 tons, the load on the turbine increases to 77 tons when the circulating water pumps are started. However as the result of a slight expansion of the condenser which takes place when it is warmed up, the springs

TABLE 1 SUMMARY OF TURBINE TEST RESULTS

Test No.	Load Average, net kw.	Duration hr.	Steam Pressures, lb. per sq. in. abs. Throttle	Turbine head	Overload, 7th stage	Heat-balance connection, 16th stage	Exhaust vacuum in. Hg[1]	Steam temp. at throttle, deg. fahr.	Superheat, deg. fahr.	Water, actual total, lb.	Water, corr. total,[2] lb.	Output, gross total, kw-hr.	Excitation,[3] kw-hr.	Output, net total, kw-hr.	Water rate corr.,[2] lb. per kw-hr.	Rankine cycle efficiency,[2] per cent	Thermal efficiency,[2] per cent
36	13,985	3	237	138	82	8.13	29.00	551	155	489,140	492,786	42,118	162	41,956	11.75	70.80	23.46
44	14,146	3	231	142	79	7.60	28.94	537	143	501,560	495,858	42,608	171	42,437	11.68	71.23	23.60
20	14,161	3	231	134	80	7.88	28.99	550	156	498,125	501,233	42,643	161	42,482	11.80	70.51	23.36
33	14,175	3	236	136	81	8.08	28.92	559	163	492,215	495,984	42,686	161	42,525	11.66	71.36	23.64
32	16,165	3	233	150	87	8.78	28.92	548	153	557,730	556,228	48,664	168	48,496	11.47	72.54	24.04
21	16,181	3	229	149	89	8.81	28.97	548	155	555,710	557,438	48,712	169	48,543	11.48	72.47	24.02
10	17,889	3	235	165	95	10.33	28.90	498	103	640,452	607,640	53,845	178	53,667	11.32	73.50	24.38
25	18,243	3	227	166	99	10.25	28.96	546	153	617,170	617,047	54,905	176	54,729	11.28	73.76	24.44
24	20,142	3	229	182	108	11.61	28.96	524	131	688,785	674,156	60,611	185	60,426	11.16	74.55	24.70
11	20,150	3	235	188	114	11.63	28.93	501	105	706,687	673,677	60,636	186	60,450	11.14	74.69	24.74
12	22,065	3	224	196	119	12.87	28.87	513	122	764,761	735,842	66,389	194	66,195	11.12	74.82	24.80
35	22,217	3	232	194	114	12.38	29.00	552	157	731,290	737,485	66,848	196	66,652	11 07	75.16	24.91
23	22,366	3	228	198	117	12.22	28.95	520	127	758,280	738,560	67,293	196	67,097	11.01	75.57	25.04
13	23,945	3	233	207	124	13.75	28.96	518	123	814,978	792,241	72,038	201	71,837	11.03	75.43	25.00
22	24,151	3	227	206	124	13.48	28.99	523	130	815,910	799,598	72,657	203	72,454	11.04	75.36	24.97
42	24,159	3	228	212	119	13.40	29.01	514	121	822,875	800,735	72,681	203	72,478	11.05	75.29	24.95
34	26,206	3	231	216	132	14.92	28.92	540	146	873,350	865,389	78,830	213	78,617	11.01	75.57	25.04
19	26,357	3	224	207	141	15.28	29.01	519	127	898,485	878,714	79,284	213	79,071	11.12	74.82	24.79
14	26,400	3	228	216	139	15.31	28.91	526	133	905,215	884,344	79,425	224	79,201	11.17	74.49	24.68
15	28,244	3	228	216	151	17.02	28.95	523	130	968,485	946,341	84,954	223	84,731	11.17	74.49	24.68
18	28,249	3	225	211	159	18.71	28.84	518	126	979,565	944,796	85,269	221	85,048	11 11	74.89	24.81
30	30,098	3	224	212	161	17.93	29.00	527	136	1,028,595	1,014,193	90,523	228	90,295	11 23	74.09	24.55
43	30,289	3	225	222	161	17 20	28.97	516	124	1,048,920	1,020,053	91,100	233	90,867	11.23	74.09	24 55
17	30,470	3	223	212	165	18.45	29.02	514	123	1,055,025	1,027,989	91,641	231	91,410	11.25	73.96	24.50
41	33,301	3	225	222	177	20.16	28.84	502	110	1,177,895	1,119,672	100,148	245	99,903	11.21	74.22	24.59
40	34,448	3	224	221	186	20.67	28.96	498	106	1,221,695	1,166,630	103,600	255	103,345	11.29	73.63	24 40
37	35,254	3	224	217	191	21.84	29.03	497	105	1,253,160	1,200,517	106,023	260	105,763	11.35	73.30	24.29
31	35,467	3	224	216	193	21.53	28.99	521	130	1,224,235	1,199,055	106,660	258	106,402	11.27	73.82	24.46
26[4]	12,991	2	235	128	75	8.35	28 98	538	142	311,700	309,257	26,085	103	25,982	11.90	69.92	23.17
29[4]	20,073	2	217	178	105	11.42	29.03	528	139	452,960	448,298	42,270	125	40,145	11.17	74.49	24.68
28[4]	25,733	2	226	209	136	13.23	28.97	519	127	587,150	572,718	51,605	140	51,465	11.13	74.75	24.77
16[5]	26,196	3	228	225	133	14 62	28 94	533	140	867,385	855,156	78,798	210	78,588	10.88	76.47	25.34
27[4]	31,568	2	223	212	171	12.13	28.99	521	130	727,290	712,192	63,292	156	63,136	11.28	73.76	24.44
38[6]	No load	0.5	234	23	17		28.15	499	104	8,925			22				
39[7]	No load	0.5	234	23	17		27.93	501	107	8,045							

[1] Referred to 30-in. barometer at 58.1 deg. fahr.

[2] As corrected to 225 lb. per sq. in. abs. pressure, 150 deg. fahr. superheat, 29 in. Hg vacuum ref. to 30-in. barometer at 58.1 deg. fahr.

[3] Including rheostat loss.

[4] Tests Nos. 26, 27, 28 and 29 made with operating governor adjusted to limit maximum loads to the values shown in the second column.

[5] Test No. 16 made with secondary valve out of service.

[6] Test No. 38 made without load on generator, with generator field current adjusted to give normal voltage on open circuit.

[7] Test No. 39 made without load on generator, generator field not excited

are compressed and a small part of this load is transferred to the supports, reducing the load on the turbine to approximately 70 tons under operating conditions. Immediately after shutting down and while the condenser is still warm but drained, the load on the turbine is reduced to 10 tons. It will thus be seen that the condenser load on the turbine varied from ten to 17 tons. The total weight of the ocndensor varies from 180 to 240 tons.

Turbine Tests

The equipment used for conducting the turbine tests consisted of two large water weighing scales for measuring the steam consumption, three single phase rotating standard watt-hour meters for measuring the output, and all the necessary thermometers, gauges and mercury columns for determining temperatures, pressures and vacua as recorded in this report.

The water weighing scales had a capacity of 25,000 lbs. each. These scales were very carefully calibrated several times throughout the tests by standard test weights and the total steam consumption corrected accordingly. The rotating standard watt-hour meters which were used for measuring output were calibrated before and after the tests by the Electric Testing Laboratories, New York City. It is believed that both the input and output were measured within an accuracy of .25 per cent. All thermometers and gauges were also calibrated in the usual manner. The specific gravity of the mercury used in the vacuum columns was determined and corrections made accordingly. The readings obtained from the mercury columns were further corrected for meniscus, temperature, and barometer reading. The barometer reading was obtained from the local U.S. Weather Bureau.

Most of the tests were of three hours duration. With the exception of a few special tests, the turbine was operated under normal conditions so far as type of load was concerned. The load was

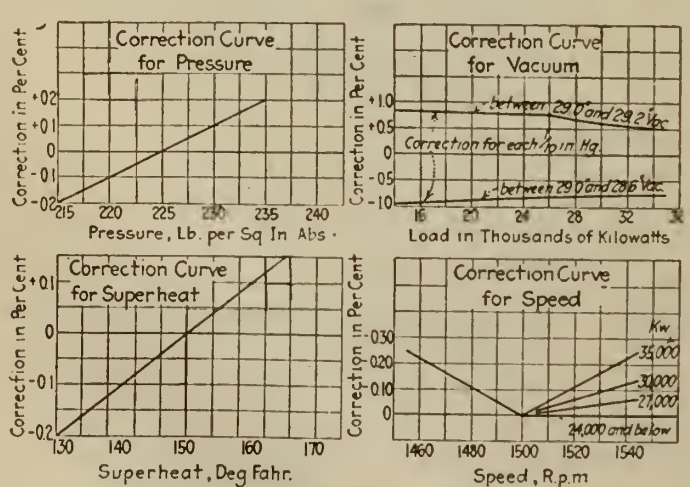


Fig. 7.—Curves for Correcting Steam Consumption to the Standa. conditions

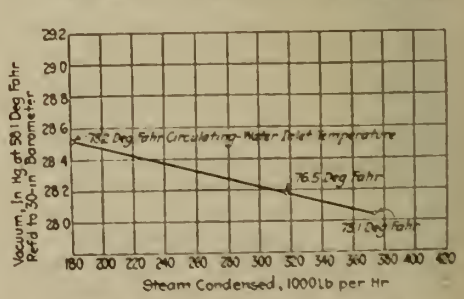


Fig. 8.—Curve showing Vacuum obtained during condenser test. Based on tests No. 2-3-4. Circulating water inlet temperature varied from 5.1 deg. F. to 78.2 deg. F. Condenser surface 50,000 ft.

TABLE 2 SUMMARY OF CONDENSER AND DRY-VACUUM-PUMP TES.

Number of Test	2	3	4
CONDENSER TESTS			
Average load, lb. steam per hour	180,666	317,000	373,666
Duration of test, hours	3	3	3
Barometer, at 58.1 deg. fahr.	29.93	29.93	30 07
Superheat at turbine throttle, deg. fahr.	41	44	50
Steam pressure at turbine throttle, lb. per sq. in. abs.	230	225	225
Vacuum, in. Hg. at 58.1 deg. fahr. referred to 30-in. barometer	28.51	28.17	28.04
Temperature corresponding to vacuum, deg. fahr.	91.6	98.3	100.6
Temperature of circulating water in, deg. fahr.	78.2	76.5	75.1
Temperature of circulating water out, deg. fahr.	83.0	86.3	86.4
Rise in temperature of circulating water, deg. fahr.	4.8	9.8	11.3
Temperature of condensate water, deg. fahr.	87.0	91.3	91.5
Circulating water (two pumps running), gal. per min.	72,500	61,500	63,800
Heat transferred per hour, B.t.u.	174,144,000	301,277,000	360,662,000
Heat transferred per hour per sq. ft. surface, B.t.u.	3483	6025	7213
Mean temperature difference (log.), deg. fahr.	10.8	16.36	19.4
Heat transferred per sq. ft. surface per hour per deg mean temperature difference	322	368	372
DRY-VACUUM-PUMP TESTS			
Vacuum at pump, in. Hg. at 58.1 deg. fahr. referred to 30 in. barometer	28.58	28.55	28.56
Temperature of air and vapor entering pump, deg. fahr.	82	82	82
Temperature of air and vapor leaving pump, deg. fahr.	185	167	160
Temperature of jacket water entering pump, deg. fahr.	68	63	63
Temperature of jacket water leaving pump, deg. fahr.	89	73	71
Speed of pump, r.p.m.	48	47	48
Steam pressure at throttle, lb. per sq. in. abs.	209	207	208
Superheat at throttle, deg. fahr.	11	17	20
Steam pressure at exhaust, lb. per sq. in. abs.	15.8	15.9	15.6
Steam consumption, lb. per hr. corrected to 225 lb. abs. steam pres., 150 deg. fahr. superheat, 16 lb. abs. exhaust pressure	1088	1029	964
Air discharged, cu. ft. per min. at 60 deg. fahr.	9.94	9.47	6.50

TABLE 3 SUMMARY OF CIRCULATING-WATER-PUMP TESTS

ECONOMY TEST[1]	
Duration of test, hours	2
Barometer, at 58.1 deg. fahr.	29.73
Steam pressure at throttle, lb. per sq. in. abs.	221
Superheat at throttle, deg. fahr.	21
Steam pressure at exhaust, lb. per sq. in. abs.	15.1
Speed of pump, r. p. m.	386
Pump discharge, gal. per min.	33,300
Total head on pump, ft.	37.63
Steam consumption, lb. per hour corrected to 150 deg. fahr. superheat	10,860
CAPACITY TEST[2]	
Speed of pump, r. p. m.	382
Pump discharge, gal. per min.	51,800
Total head on pump, ft.	20.60

[1] Test made with discharge valve adjusted to give approximately normal operating head.
[2] Test made with discharge valve wide open.

TABLE 4 SUMMARY OF CONDENSATE-PUMP TEST

Duration of test, hours	1
Barometer, at 58.1 deg. fahr.	29.79
Steam pressure at throttle, lb. per sq. in. abs.	216
Superheat at throttle, deg. fahr.	28
Steam pressure at exhaust, lb. per sq. in. abs.	15.2
Speed of pump, r. p. m.	1495
Pump discharge, lb. per hour	475,000
Suction head, in. Hg	26.2
Discharge head, ft.	60.9
Total head on pump, ft.	90.64
Steam consumption, lb. per hour corrected to 150 deg. fahr. superheat	1840

the remote governor control system provided for that purpose. This method of controlling the load subjected the turbine to the full swings of the railroad load.

Table 1 gives the numerical results of the turbine tests, while the performance is shown graphically in Figs. 4, 5 and 6. Fig. 4 gives the total steam consumption and water rate of the unit, while Fig. 5 gives the thermal and Rankine-cycle efficiency. From these curves it will be seen that the lowest water rate obtained while operating under normal conditions was 11.03 lbs. per kw. hr., while the highest Rankine and thermal efficiencies obtained were 75.5 per cent and 25.0 per cent., respectively. As stated above, all tests with the exception of seven were conducted under operating conditions.

In order to determine the effect of the swinging load on steam consumption, four tests were conducted with the governor blocked so that the unit operated under a steady load. These tests are shown in Fig. 4 and 5 by the small square It will be seen that there is no improvement in the efficiency under the steady load conditions at the loads selected for these tests. When the turbine is operated under normal conditions and carrying loads from 22,000 kw. to 25,000 kw. the secondary valve is continually opening and closing, which no doubt reduces the economy somewhat. If a steady load test had been conducted within this range the points would probably have fallen on the dotted curve. The test shown by the small triangle in Figs. 4 and 5 was run with the secondary or overload valve closed and out of commission, while the load was adjusted so that the primary valve was wide open. As was to be expected, the lowest water rate was obtained while operating in this manner. Since the completion of these tests the governor cams have been modified so that the opening of the secondary valve is delayed.

This may improve the economy to some extent near and at the best load point, however no tests have been conducted to determine just how much improvement has been accomplished.

Test No. 38 was run without any load on the generator, but with the field excited to give normal voltage on open circuit. The actual steam consumption per hour during this test amounted to 17,850 lbs. Another no load test was conducer, but without any excitation, during which the actual steam consumption amounted to 16,090 lbs. per hour. No attempt was made to correct the steam consumption during these two no-load tests, due to the vacuum being low and outside of the range of the correcting curves.

Fig. 6 shows the variation of steam pressure with the load at various points throughout the turbine. In order to correct the steam consumption to the standard conditions, the curves given in Fig. 7 were used.

Water-rate Factor

In order to make an absolute and numerical comparison of the flatness of water rate curves for different turbines, an expression has been used which is termed the water rate factor. Expressed mathematically,

$$F = \frac{MW}{C}$$

in which F = water-rate factor; M = minimum water rate obtained; W = mean load between one-half rated load and maximum load, which is the usual operating range; and C = average total steam consumption per hour covering the range between one-half rated and maximum load.

(Continued on page 27)

The Craftsmen's First Canadian Convention

Excellently planned, and well carried out, this convention has set a high mark for other engineering societies to follow. The exhibition of power plant appliances was a very big feature.

THE City of Toronto was the scene of great activity in so far as engineering circles went, during the week of August 1st, when the Universal Craftsmens Council of Engineers held their first Canadian Convention. Though the first time the Convention has been held in Canada, the order has held many in the United States, where the membership and number of councils are very large.

Probably more men in charge of large stationary engineering plants were in the city of Toronto during that week than at any previous time in the City's history. From the first thing Tuesday morning when the delegates and visitors were welcomed to the city by the Mayor, things went with a swing, and the King Edward Hotel was full of bustle and cheer as the delegates and their companions circulated from meeting place to exhibition hall, and stopped to chat to old and new friends in the course of their journeyings.

The Exhibition

Everybody who found their way into the Pompeian Room, whether from idle curiosity, or a genuine wish to see and learn, which was the motive of the majority, was enthusiastic over the display that was put on there by the various firms exhibiting. There was very little in the way of accessories and equipment for plants that was not in evidence in that room. The arrangements of the booths that had been carried out by the Craftsmens Committee was such as to give general satisfaction to all those who had taken space. On entering the room a fairly comprehensive view of there was ample room in the aisles bethe whole thing could be obtained, and tween the booths to walk round and view the various exhibits, and to stay awhile where one was most interested.

The firms holding space were the following:—Beldams Canadian Asbestos Co., showing a full line of packing, steam and hydraulic. Crouse Hinds Co. of Canada Ltd., Electrical fittings and conduits. James Morrison Brass Mfg. Co., Steam gauages, injectors, valves. Chapman Double Ball Bearing Co., Working model of ball bearing. Canadian Johns Manville., Asbestos products. Kirby & Co., Packing etc. Demco Machine Tool Co., Patent Hotwater Mixing valve. Refinite Co. of Canada., Water softening apparatus. Superheater Co. of Canada., Superheaters. S. K. F. Ball Co., Working models showing ball bearings. Valve Engineering Co., Valve specialities. Otis Elevator Co., Elevators. Moving pictures illustrating productive methods. Canadian Sirocco Co., Fans and Blowers. Dominion Flow Meters and Co., Recorders. Everlasting Valve Co., Everlasting Blow Off and other valves. Dearborn Drug & Chemical Co., Boiler Water Treatment. Jenkins Valve Co., Various valves. Underfeed Stoker Co. of Canada., Model of underfeed stoker and Coles Regulator. C. A. Dunham Co., Heating appliances, radiater traps. Canadian Powers Regulator Co., Patent thermostats for temperature regulation. J. H. Wenting, Mason Contractor, Fire brick, etc. Crane Ltd., Steam and Water Valves, Pipe Fittings, etc. Allen General Supplies, Copes Boiler Feed Regulator, and power plant supplies. William C. Wilson, Packing, Boiler Cleaner etc. Darling Bros., Heating specialities, pumps etc. W. R. Sexton Boiler Setting Co., Non-pareil grate bars, boiler setting. Taylor Instrument Co., Full line of thermometers, pyrometers, recorders. Lumkenheimer Valve Co., Valves. Garlocq Packing Co., Packing. McColl Bros., Lubricants. Hollow Centre Packing Co., Oils and Lubricants. Black Donald Graphite Co., Graphite. W. H. Cunningham & Hill Ltd. Canadian Blower & Forge Co., Fans and Blowers. Pierce Fuse & Devoe Switch., Patent Fuses and switches. Henry Engineering Co., Vesta Storage Battery. Taylor & Arnold Co., Recorders. Home Rubber Co., Packings and rubber goods. Keystone Grease Co., Lubricating Grease.

The Entertainments

The programme was carried out exactly as arranged by the Committee, and the visitors were certainly shown all Toronto had to offer. On Wednesday evening about 55 automobiles were required to convey the delegates and their ladies on a trip around the city. This was conducted under the auspices of the chief of police, who did away with all traffic difficulties, and handled the affair in a way that brought much praise from those who enjoyed the benefit of this care. The drive covered all the most interesting spots in and around the city, and was destined to give the American visitors food for reflection, as by the remarks passed it evidently did. It was amusing to note the surprise evinced by many of those coming from the middle western and southern states, who had never been in Canada before at actually finding such a city. Many of them were so much impressed that they expressed a wish to remain here altogether, although we think they might revise that opinion if they were to visit here in one of our old fashioned winters.

The drive was followed by a most enjoyable dance at the Sunnyside Pavilion, which lasted well on till midnight, and was a very fitting close to an enjoyable day.

The big event as far as the menfolk were concerned, was the picnic at the Island on the Thursday afternoon. Everybody got together for this event, and the sun, who had been rather coy for the first day or two, came out in his full regalia to see that the thing went right. Centre Island proved another eye opener to the American visitors, and we believe there will be a vast amount of good advertising accruing to Toronto in particular and Canada in general as the result of this convention.

Arrived at the Island, the programme of sports was got under weigh without any delay, and the resulting races were enjoyed by all present. The following races were run off:—

Tot's Race—Won by D. Allman, Ida Otis second.

Girl's race, under 8—Won by M. Rumley, A. Chalmers second.

Boys Race, under 8—Won by D. Allman, J. Serton second.

Girl's Race, under 12—Won by Evelyn Otis, Elsie Ottis second.

Boy's Race,. under 12 — Won by A Auchterlonie, H. McLaren second.

Mens 100 yards—Won by E. Worthington, H. Thompson second.

Ladies 50 yards—Won by Miss Woodman, Miss Marden second.

Ladies Heavyweight, 50 yds.—Won by Mrs. Aucherlonie, Mrs. Buckley second.

Mens Heavyweight, 75 yds.—Won by A. Auchterlonie, H. Parker, second.

Cat Race, Lady & Gentleman, 50 yds. —Won by E. Worthington and Miss Woodman.

Members of Canada Council, 45 and over, 75 yards—Won by J. Parkes.

Past Grand Chief's Race, 50 yards—Won by H. E. Terry.

Ladies Committee, 50 yards—Won by Mrs. Allman, Mrs. Potter second.

The big event was the baseball match between the Craftsmen and the exhibitors, which was productive of heavy hitting, wonderful base running, and weird umpiring. During the five innings which it lasted, we can truthfully say that there was not a dull moment and the yells that went up from the side lines would have put a whole tribe of Comanches to shame. The gentlemen who were keeping the score for either side added as many runs at the end of each inning as they thought their team required and through their efforts the game resulted in a tie. As a matter of fact the exhibitors were getting runs that fast at one stage of the game that an adding machine would have been necessary to count them all. However, all things must end, even such a ball game, and the contestants lined up for the official photograph, which included all present. This photograph was on a scale which makes it difficult to reproduce in our pages, as the figures would appear too

small when reduced to the dimensions required. However it was an excellent photograph.

After the photograph supper was served, and those who felt like it drifted away to the dancing pavilion and finished up the evening in that fascinating pursuit. The others rested in the cool glades of Centre Island till time to return to the city bed.

The final entertainment was on the Friday night, when nearly 400 delegates, visitors, exhibitors sat down to a banquet in the Tabard room of the King Edward Hotel. An excellent repast was provided, following which there was an entertainment interspersed with speeches. The entertainment was in the hands of Mr. Chas. Leslie, Miss Vera McLean and Mr. Jimmie Reid, and their efforts were very well received, they being repeatedly recalled after each number. The speeches were brief, and to the point, and every speaker expressed the pleasure he had received in attending the convention, while Mr. Cudbird and his committee came in for unstinted praise. The speech of the evening was delivered by Mrs. Aldridge, President of the Ladies Council, in replying to the toast of the Ladies Council. Mrs. Aldridge possesses a full clear voice, which she uses admirably, and a command of vigorous clear cut English which put to shame most of the male speakers.

Conclusion

It must not be imagined that the convention did nothing but have a good time. The members of the local Councils and the delegates from the various councils in the States who attended were in session a goodly portion of the time. The result of the discussion re the next year's convention was that Cleveland will have the honor.

Mr. L. J. Cudbird, to whom must go the larger share of the credit for the success of the event, was honored by election to the Grand Lodge of the Council. He was also presented with a very handsome club bag for his efforts by the Grand Lodge. Mr. Terry, the secretary-treasurer who also had a large part of the burden, came in for special mention. The members of the committee as on the result of their efforts, which brought about such a smooth running and well managed convention.

The firms that had exhibitions in connection with the convention were all very highly pleased at the treatment they received, and at the number of visitors that came to their booth. They were kept busy in between the business sessions showing and explaining their goods to the interested crowds that came around.

There will without doubt be a great deal of benefit accruing to those who exhibited, even if it cannot be directly traced We must say for our part that quite a number of American visitors took away copies of Power House, and were very much interested to find that Canada had a technical publishing house of its own.

It is one of the greatest benefits of these Conventions and exhibitions that they tend to break down the wall of ignorance which stands between us and so many of our Southern neighbors. While the average Canadian knows pretty much about the States, the ideas entertained by some citizens of the U. S. about Canada can only be dispelled by a personal visit, and it is just such conventions as this that gives them the chance to widen their minds.

As we said in our editorial last week, the Craftsmans Council have done a service to the engineering profession, their city and their country, by having the courage to enter into such a large undertaking and carrying it to a succesful conclusion.

EFFICIENCY TESTS OF A 30,000 K. W. TURBINE

(Continued from page 25)

Using the curves given in Fig. 4, substitutions may be made as follows:

$$F = \frac{11.03 \times 25{,}000}{280{,}100} = 0.985$$

This factor could be expressed by using the ratio between the minimum water rate and the average water rate over the range selected. However, the factor obtained in this manner would not take into account the fact that it is more desirable to obtain flatness in water-rate curves at the high loads than it is at the low loads. By using the total steam consumption as indicated in the expression given above, a fairer comparison is obtained.

Condenser and Auxiliary Tests

Tests were conducted on the condensers and auxiliaries. A summary of the condenser and dry-vacuum pump tests, which were run simultaneously, is given in Table 2, while the relation between the load and vacuum is shown graphically in Fig. 8 In examining the results of these tests and comparing them with the vacuum obtained during the turbine tests, it should be kept in mind that the temperature of the circulating water during the condenser tests, which were run during the summer, was very high, varying from 75.1 deg. fahr. to 78.2 deg. fahr. The methods used in determining the quantities given in Table 2 need no description, with the possible exception of the measurement of the air discharged from the dry-vacuum pump and the steam consumption. The air was measured by a gasometer connected to the discharge of the pump. The steam consumption was determined by condensing the exhaust steam in a small test condenser, after which it was weighed in the usual manner.

Table 3 gives the results of the tests on the circulating-water pump. It will be seen that two tests were conducted on these pumps, one being an economy test while the other was a maximum-capacity test. Only one of the two pumps was running in either test. During the economy test the discharge valve was adjusted to give the normal operating head which exists when two pumps are running, while in the capacity test it was left wide open. The quantity of water pumped was computed by the heat-balance method, which involved the measurement of the main turbine condensate, its temperature, the temperature of the circulating water in and out, the steam conditions at the main-turbine throttle, load on main unit, etc. The steam consumption of the turbine driving the pump was determined by means of the small test condenser mentioned above. The results of the condensate pump test are given in Table 4.

HANOVER LODGE C. A. S. E.

The Hanover Lodge C.A.S.E., one of the youngest lodges in the organization, held its second annual picnic on Monday August 1st civic holiday. A good muster turned out for the occasion, and the Federal member for Hanover Mr. R. J. Ball, gave an interesting address on the value of education for the engineer, and his employer. In this connection it is iteresting to note that the manufacturers of Hanover have given the lodge the use of a building to hold their regular meetings in.

THE SMALLEST PUMP IN THE WORLD

What is the smallest pump in the world? This is a difficult question to answer, but it would be equally difficult to light upon any pump at once smaller and simpler than that recently devised by a British Engineer. It consists of a piece of rubber tubing bent into a hoop, with a wooden frame outside the loop and a circular cam inside. By placing the cam out of centre and revolving it the rubber tube is squeezed in a rotary direction, giving a kind of "milking" action which will force liquid through it. One end of the tube then becomes the suction pipe and the other te delivery pipe of a very neat and efficient form of pump. The inventor after having made a pump out of a serviette ring and piece of rubber tubing, has take out a patent for a regular engineering mechanism on the same principle. He proposes to use a flexible rubber or leather band suitably water-sealed on its width, in place of the tubing, and cast iron or gun metal casing with suction and delivery branches. This type of pump, it should be noted, has no valve and will therefore be suited for use in cases where pump valves are apt to give trouble.

The handy wiring tables and illumination data just issued by the Ceo. Cutter Works of the Westinghouse Electric & Mfg. Company at South Bend, Ind., contains a considerable amount of data which is of interest to anyone connected with the problems of wiring and lighting offices, factories, etc. Tables of foot candle intensities recommended for different classes of service, are included in this booklet, and an interesting discussion of lighting installations is made. Several new devices manufactured by the Westinghouse Company are shown in this booklet.

Description of New Type of Water Turbine

This Outline of a New Type of Turbine Was Given at the Sym posium on Hydro-Electric Development Held in January Last Under the Auspices of the Engineers Club of Philadlephia

By L. F. Moody

IT seems, from a review of papers read before the Symposium on Hydro-electric Development and Distribution, held in January under the auspices of the Engineers' Club of Philadelphia and the principal engineering societies of America, that the forecast made by Mr. Anderson, just a year ago, at the Institution of Mechanical Engineers, was quite true, and that the water turbine, having passed through a stage of rather complex design, is reverting to a much more simple axial flow form, and that this tendency towards simplicity does not involve any sacrifice of adaptability.

Within comparatively recent times it was considered necessary, in order to obtain the speed required for driving electric generators, to use several turbine runners on one shaft, specially in cases where large powers had to be developed with only moderate heads. The use of multiple runners—as many as eight have been used in one turbine—naturally led to complication in the vane mechanism, while the tortuous water passages involved by the arrangement were a serious handicap to efficiency. Careful investigation of the conditions has however indicated that this complication is unnecessary, and Mr. L. F. Moody gave an outline, at the Symposium just mentioned, of a new type of turbine possessing even greater simplicity than those of a generation ago, but nevertheless capable of adaptation to the requirements of modern hydro-electric plants.

The evolution of this new type of turbine has come about through the mathematical study of the conditions of water flow, and Mr. Moody gave an analysis of this study in his paper. With the forms of mixed flow turbine which have recently been in vogue, that is to say, turbines with runners in which the direction of flow of the water was changed several times in the course of its passage from the inlet to the outlet, it has been practically impossible to employ mathematical principles in designing the passages, and the theories which have been put forward have been of little assistance to the engineers. Mr. Moody, however, started by setting down the fundamental requirements of a turbine without reference to any indivldual machine. These requirements are given below in his own words:—

"(1) A casing in which the water can approach the runner symmetrically with respect to the axis on all sides, without any obstructions or enforced abrupt changes of flow which would introduce eddies or unsymmetrical distribution of velocity. The spiral or volute casing meets these conditions, and in most cases is the most satisfactory form of intake. On account of the increase in the velocity of the water from a low value in the intake to a high value where it passes through the runner, the water passage must contract radially as it approaches the runner, and must subsequently expand again. The approach of the water to the runner therefore involves a radial component of flow toward the axis and by so-called speed vanes of stay vanes, and by the movable guide vanes or gates the water is given increasing whirl or rotationa components of motion about the axis as it nears the runner. After leaving the guide vanes the water continues to increase in velocity of whirl due to its closer approach to the axis, and at the same time it turns in the meridian plane and takes the axial direction either just before, during, or just after its passage through the runner.

"(2) A wide transition space is provided between guide vanes and wheel vanes and in this space the water can come together in a continuous whirling mass before entering the runner. In a high-specific-speed turbine the water continues to contain whirl components of motion, but of somewhat reduced amount, after leaving the runner, even when the turbine is operating at its point of best efficiency.

"(3) After leaving the runner the water continues to flow as a whirling, axially advancing stream in a draught tube having a straight axis coincident with that of the turbine, and conical or flaring walls, this form of tube continuing, if what the writer believes to be the best practice is followed, until the velocity head has been reduced to so low a value that no serious disturbance in the symmetry of the flow into other directions or by finally discharging the water."

The specific speed referred to in the second paragraph above is, of course, the basis of comparison for turbine runners, or the number of revolutions per minute which a similar wheel would have to run at, at maximum efficiency, to develop 1 horse-power with a head of one ft. to 20 ft., whie the specific speeds of tion turbines range from about 20 to 100 inversely as the head varies from 750 ft. to 20 ft., while the specific speeds of Pelton impulse wheels lie between one and seven.

In looking forward to the future development of the turbine, Mr. Moody shows that theoretical considerations call for a conservative proportioning of the various velocities and angles of the turbine, and that there is no apparent means of greatly increasing specific speeds merely by using some new and radical proportion between the velocities. Efficiencies are already so high that no starting increase is possible. The prospect of further increases in specific speed therefore lies entirely in the use of higher velocity

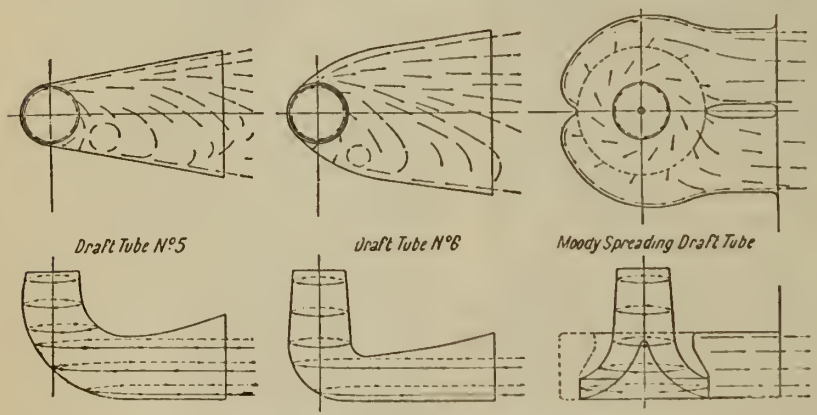


Fig. 1.—Alternative Forms of Draught Tube

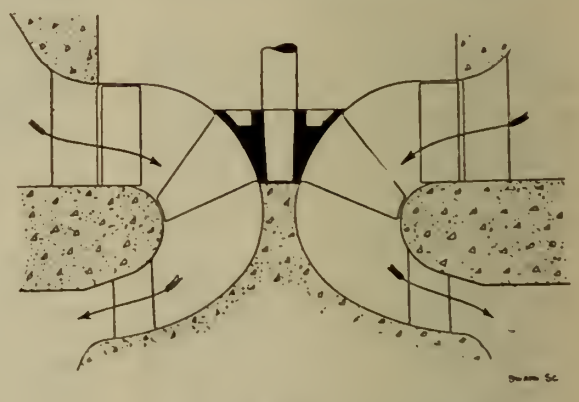


Fig. 2.—A New Type of Turbine

heads in comparison with the head on the plant, and an avoidance of serious impairment of the efficiency, by giving attention to the securing of low coefficients of loss in the runner and draught tube, and by observing the relations between the velocities of outflow from the runner.

Reverting to the turbine which will meet the conditions laid down above, it may be viewed as a water passage having walls which are surfaces of revolution and containing a continuous body of water which is both whirling and progressing with radial and axial velocity components, in which is placed a runner which develops torque by reducing, but not necessarily destroying, the whirl components of the flow. If a draught tube is used which is capable of regaining a considerable part of the energy due to the whirl components, as well as that due to the axial components of the velocity if discharge from the runner is reduced to a small fraction ly be secured, the "outflow loss" from the runner is reduced to a small fraction

sible to lose 17 per cent. of the total head with a design of draught tube which fails to regain any of the velocity. For low specific speeds such as 20, the axial component is less than 2 per cent. of the total head and the whirl component is entirely negligible. Therefore, for low specific speeds the design of the draught tube is not important from the viewpoint of efficiency.

A long, straight draught tube with a small angle of diffusion is probably the most efficient design, but for large units such a construction would involve costly excavation, and hence some form of curved tube must be adopted. Fig. 1 shows different types of draught tube designs. The losses caused by changes in the direction of flow are severe. The water leaving the runner is whirling in the same direction as the runner rotates, the centre of the vortex being the vertical axis of the draught tube. This vortex tends to remain in the same plane on account of its gyroscopic properties, and will not therefore follow the centre line of the curved type of tube. As in-

a similar machine with a curved tube. Photographs of a power plant where Moody draught tubes have been installeded show how smooth is the flow of the water in the tail-race as compared with the turbulent, frothy discharge from the curved draughts of the older units.

Reasoning on the same principles, Mr. Moody suggests the use of continuously curved inner and outer surfaces of revolution for the turbine water passages, thus avoiding all sudden changes of curvature. Fig. 2 shows, in outline, a turbine embodying these principles. The entrance passage merges into the runner space and the latter merges into the draught tube. The flow passes into the draught tube by continuous gradation, with gradual changes in the whirl about the turbine axis, and without sudden variations of the secondary whirl occurring in the meridian plane, i.e., the plane of the figure.

If a ring of vanes such as a runner is interposed in the revolving mass of

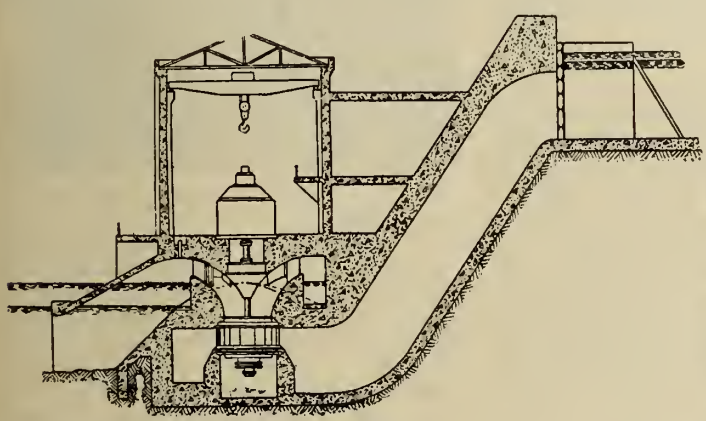
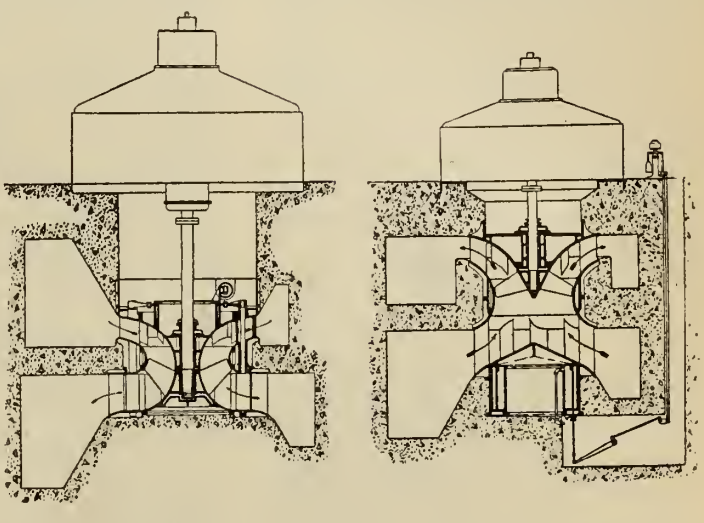


Fig. 4.—Suggested New Arrangement of Turbine



Figs. 5 and 6.—New Turbine with different types of control.

of that which enters into the usual text-book formulas.

The laws which govern a vortex can be applied to investigating the flow of water through such a turbine, and it follows that the velocity if whirl varies inversely as the radius. This fact introduces an important consideration in the design of the draught tube, as it enables the whirl velocity, at the discharge of the runner, to be gradually reduced and regained as presure head.

Dealing with this part of the subject, in another paper read before the Symposium, Mr. F. H. Rodgers said that for a specific speed of 80 the energy at the discharge of the runner to be regained in the draught tube amounts to 11 per cent. of the total available head for the axial velocity and six per cent. of the total head for the whirl velocity. The total energy to be regained in the draught tube is represented by the sum of these values. For high speed runners therefore draught tube design is of great importance, for no matter how efficient the runner may be in itself, for the case assumed above, it is pos-

dicated in the figure, with this type of tube serious eddies and whirls occur in the curved portion, so that at the discharge of the draught tube it is usually found that but a portion of the discharge area is effective. Water from the tail-race actually flows in the reverse direction back into part of the tube, thus causing serious eddy losses and high outflow losses in the other portion of the tube. The tube 6 shown in this figure is slightly better than tube 5, as the straight portion of the tube is longer and hence the whirl components are somewhat reduced before the water enters the curved portion of the tube.

In the case of the Moody spreading draught tube. The flow passes into the metrical about the axis of the turbine, and the whirl velocity is greatly reduced before the water is discharged into the surrounding chamber. The axial component of the flow is regained and most of the whirl component also saved. Laboratory tests have shown that a turbine equipped with one of these draught tubes possesses an efficiency higher by one per cent. than that of

water, the torque exerted on the vanes by the water is equal to

Where W is the weight of water, r1 and r2 the radii of entry and exit of the runner, respectively, and cu1 and cu2 the corresponding circumferential components of velocity. Fig. 3 shows the form of runner employed in this new type of high-speed turbine.

The natural outcome of adopting the high specific speeds associated with this class of turbine is an increase in the velocity head at the discharges. In order that the absolute pressure at the runner discharge may be kept at a value giving a margin above the point at which water will vaporize, and to provide the head necessary for the retardation of flow during quick gate closures, the sum of the static elevation of the runner above the tail water and the regained velocity head should not approach too closely to the barometric height, and preferably should not be more than 27ft.

In order to meet this requirement and yet permit the adoption of high specific

(Continued on page 31)

Amendments to the Ontario Engineers Act

A PERSON who desires to operate a stationary steam or gas plant of between 25 and 50 H. P., or to operate under a certificated engineer a stationary steam or gas plant of 50 H. P., or over, when the safety valves are set in such a manner that they cannot relieve the pressure at ten pounds or less, must hold a Fourth-class Certificate. (Application forms for this purpose will be supplied on request).

A candidate for Fourth-class Certificate shall be required,

(a) To be at least 19 years of age;

(b) To take an affidavit on a form supplied by the Board, showing that he has had the required six months' initial operating experience, including at least three months' operating experience in the boiler room;

(c) To satisfy the Board as to character and ability;

(d) To pay a fee of Three Dollars at the time application is made for examination. (This fee shall not be returned to the applicant should he fail to pass the examination);

(e) To answer the questions on the examination paper and secure at least sixty per cent of the marks.

Third-Class Certificate

A person who desires to operate a stationary steam or gas plant of between 50 and 200 H. P., or to operate a stationary steam or gas plant of over 200 H. P., under a certificated engineer, when the safety valves are set in such a manner that they cannot relieve the pressure at ten pounds or less, must hold a Third-class Certificate. (Application forms for this purpose will be supplied on request).

A candidate for Third-class Certificate shall be required:

(a) To be at least 21 years of age;

(b) To be a holder of a Fourth-class Ontario Certificate of the current year or its equivalent in H. P., from one of the other Provinces of the Dominion;

(c) To take an affidavit on a form supplied by the Board to the effect that he has had at least two years' experience operating in a stationary steam or gas plant, showing at least six months' experience in a boiler room and six months' experience in an engine or compresser room;

(d) To pay a fee of Five Dollars at the time of making application for examination. (This fee shall not be returned to the applicant should he fail to pass the examination);

(e) To answer the questions on the examination paper and secure at least sixty per cent of the marks.

Second-class Certificate

A person who desires to operate a stationary steam or gas plant between 200 and 600 H. P., or to operate a stationary steam or gas plant of 600 H. P. or over, under a certificated engineer, when the safety valves are set in such a manner that they cannot relieve the pressure at ten pounds or less, must hold a Second-class Certificate. (Application forms for this purpose will be supplied on request).

A candidate for Second-class Certificate shall be required:

(a) To be the holder of a Third-class Certificate of the current year or its equivalent in H. P. from one of the other Provinces of the Dominion;

(b) To take an affidavit on a form supplied by the Board, to the effect that he has served an apprenticeship of at least two years as a stationary engineer, erecting engineer, machinist, boiler maker or blacksmith, or has completed at least a two- year course in Science or Engineering in any University. To take an affidavit to the effect that, in addition to his apprenticeship or University Course, he has had three years' experience in the operation and charge of a steam or gas plant, including at least one year's experience in the boiler room and one year's experience in the engine or compressor room;

(c) To pay a fee of Seven Dollars at the time of making application for examination. (This fee shall not be returned to applicant should he fail to pass the examination):

(d) To answer the questions on the examination paper and secure at least sixty per cent of the marks.

A person who desires to operate any steam boiler and engine or steam boiler, working with the safety valve set in such a manner that it cannot relieve the pressure at twenty pounds or less, irrespective of horse power, when used for the purpose of operating steam shovels, steam locomotive cranes, steam derricks, steam hoists, steam drags, and all other similar apparatus used for hoisting and excavating purposes, must hold a Hoisting Engineer's Certificate from this Board.

First-Class Certificate

A person who desires to operate a stationary steam or gas plant of 600 H. P. or over, when the safety valves are set in such a manner that they cannot relieve the pressure at ten pounds or less, must hold a First-class Certificate issued upon examination by the Ontario Board, (Application forms for this purpose will be supplied upon request.

A candidate for First-class Certificate shall be required:

(a) To be the holder of a Second-class Certificate of the currant year or its equivalent in H. P. from one of the other Provinces of the Dominion:

(b) To take an affidavit on a form supplied by the Board, to the effect that he has served at least three years' apprenticeship as a stationary engineer, erecting engineer, machinist, boiler maker, or blacksmith, or has completed at least a three-year course in Science or Engineering in any University to take an affidavit to the effect that he has had at least seven years' experience, in addition to his apprenticeship or University Course, as Chief or Operating Engineer of plants of Two Hundred H. P. or over;

(c) To pay a fee of Ten Dollars at time of making application for examination. (This fee shall not be returned to the applicant should he fail to pass the examination:

(d) To answer the questions on the examination paper and secure at least seventy per cent of the marks.

Portable Engineers' Certificates

A person who desires to operate any steam boiler and engine or steam boiler, working with the safety valve set in such a manner that it cannot relieve the pressure at twenty pounds or less, irrespective of horse power, when used in the operation of steam road rollers, steam tractors, steam locomotives, steam waggons not using flash boilers, well drillers, portable saw-mills, and all other similar apparatus used in the operation of portable work, must hold a Portable Engineer's Certificate from this Board.

A person who desires to operate any steam boiler and engine or steam boiler, working with the safety valve set in such a manner that it cannot relieve the pressure at twenty pounds or less, irrespective of horse power when used in the operation of concrete mixers, drills, pumps, air compressors and heating systems temporarily intalled during construction work, must hold a Hoisting Engineer's certificate or Portable Engineer's Certificate from this Board.

A candidate for Hoisting or Portable Engineer's Certificate shall be required:

(a) To be at least 19 years of age;

(b) To take an affidavit on a form supplied by the Board to the effect that he has had at least fifteen months' operating experience in a steam plant, including three months' operating experience of a hoisting steam plant in the case of a Hoisting Engineer, and three months' experience in a portable steam plant in the case of a Portable Engineer:

(c) To satisfy the Board as to character and ability;

(d) To pay the fee of Five Dollars at the time application is made for examination: (This fee shall not be returned should the applicant fail to pass the examination):

(e) To answer the questions on the examination paper and secure at least sixty per cent of the marks.

NEW TYPE OF TURBINE

Continued from page 29

speeds, with corresponding outflow velocities, Mr. H. B. Taylor has suggested that the runner of the turbine should be put, if necessary, below the level of the tail water and arranged to discharge upwards. By making the discharge flow over a crest, or weir, set at a level above that of the tail race, it is then possible to unwater the turbine whenever it is necessary, for inspection or similar purposes.

A plant arranged according to these ideas is shown in Fig. 4, while Figs. 5

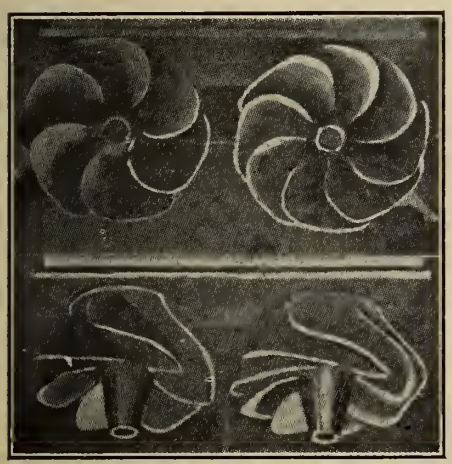


Fig. 3. New Type Turbine Runner

and 6 illustrate turbines adaptable to such a scheme.

In Fig. 4 the turbine is arranged with wicket gates or movable guide vanes, operated from below, in a pit provided for the purpose. The draught tube is of the spreading type, the outer barrel of the tube being used to form a circular crest to exclude the tail water when access is desired to the interior of the turbine. The procedure would be to close the head gates and to pump out the water contained by the draught tube and turbine passages by the use of centrifugal pumps or an hydraulic ejector.

Without going into all of the new features opened by this arrangement, it may be mentioned that the turbine casing, which is under a considerable amount of pressure, is placed at a low level in the power-house substructure, where there is a large mass of concrete above it to counteract the upward pressure of the water. An excellent design of draught tube can be used without requiring any increased depth of excavation.

The arrangements shown in Figs. 5 and 6 can be readily understood from the drawings. In the turbine in Fig. 5 wicket gates are used with the guide vane stems carried up through, or in line with, the draught tube stay vanes, which are used to support the superimposed structure, and outside operating mechanism is used, arranged in the usual manner in the turbine pit. In Fig. 6 a plunger gate is used instead of the usual wicket gates, this plunger being operated by hydraulic pressure.

"WHY DO RIVETS LEAK"

The real underlying cause for leakage at the riveted joints of boiler plates is often times difficult to place, necessitating a thorough consideration of the details in their design and construction. The answer to this question, "Why do rivets leak?" is one upon which much time and money has been spent to find a satisfactory answer. Modern investigation has, however, revealed the fact that the answer is partly found in the rivet itself,—its constitution and its physical structure.

It will be of interest to many to know that scientific methods of steel making combined with rigid chemical and physical testing does exclude the possibility of sulphur or phosphorus being present in high enough amounts to cause ruinous "cold" or "red shortness" in the rivet metal. In addition to this, the physical structure of the metal is given the utmost consideration by the progressive rivet manufacturers of today, who subject their steel to a process of cold working and annealing which increases greatly the strength and ductility of the rivet.

Failure of a joint is due at times to the selection of unsuitable rivets of such proportions that they must be unduly worked and strained to fill the rivet hole and form the head. It is also necessary that there be enough material to form a head that is at least as strong as the body of the rivet, and that the body length be not more than six times the diameter, since the stresses induced by contraction of the body increase with the length and may become so great as to cause the head to fly off.

Faulty design of joints is another contributor to leaking and failure. So careful consideration must be given to the type of joint used—whether it be lap or butt; single riveted, double riveted, triple riveted,etc. The pitch and diameter of the rivets must be so proportioned that the strength of the rivets in shear will approximate the strength of the plate against tearing; while both must be of such strength to withstand any shearing, bending or tensile stress they may receive. Reference to well established formulae abundantly illustrated that the stress in a girth lap seam works out at one-half the stress in a longitudinal joint. As a consequence it is permissable to use a lap joint for a girth seam, even though its strength is only a little better than one-half that of the butt seam. It should be noted, however, that the lap seam has a tendency to break or crack along the seam, which of course results in leaks.

Even the method of making the rivet holes may be responsible for the leaking of a boiler. Punched holes decrease the tensile strength of the plate between holes from 8 to 35 per cent. This may be corrected if the diameter of the hole is increased ¼ in. by seaming or drilling, thereby removing deformed material. If the holes are drilled instead of being punched the tensile strength of the plate between holes is increased 10 per cent. (for the spacing generally used). In many cases it happens that rivets are overheated before being driven and are consequently very susceptible to failure.

Riveters themselves are sometimes at fault, for there are many factors in driving rivets that need to be carefully observed if the resultant joint is to be tight. The plates being riveted should be held firmly together with tack bolts; and the rivets themselves should be hammered in place until redness disappears. This will prevent yielding of the head of the rivet, and the tension created by the contraction of the rivet shank in cooling will create high friction between the plates and prevent them from slipping. The importance of this point will be appreciated when it is considered that the rivets also contract laterally and do not completely fill their holes when cold. Before shearing can take place in rivets it is consequently necessary that the plates shall slip on each other. This slipping, which if in any appreciable amount will cause leaking, is prevented by the contact friction of the plates induced by the tension in the rivets and i creased by proper caulking.

The final operation to prevent leaks is caulking. A good job of caulking, as stated above, increases the strength of a joint by increasing the resistance of the plates to slipping. To secure a maximum of safety and strength rivets and plates should be caulked on both sides.—"Steam."

New Oxygen Plant Augurs Industrial Improvement—In these days of general industrial improvement it is refreshing to note the spirit of optimism evidenced in the announcement recently authorized, that the Dominion Oxygen Company, will break ground in mid-July for a new quarter-of-a-million-dollar oxygen plant at Montreal, which will double the company's present capacity. The building will be 100 ft. × 100 ft. and, will be substantially a duplicate of the company's Toronto plant, which until now has supplied oxygen to Canadian industrial users through five district distributing stations. The Montreal plant will be the second of five producing plants projected at the time the company was organized last year.

Graphite Lubrication, is the title of a neat booklet published by the Quebec Graphite Company, Buckingham, Que. Miners, millers and refiners of lubricating flake graphite. The contents describe the different characteristics of one of Canada's leading products, how the flake graphite is separated from the other grades and used for lubricating purposes, while the finer grained portion is used for lead pencils, stove polish, foundry facings, etc. Several views are shown of mines, concentrating plant, power plant, etc. All told, it is an interesting descriptive book.

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POWER HOUSE

AUG, 20th, 1921

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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The Perennial Smoke Consumer

THE SMOKE consumer, like the poor, we have always with us. It comes, like the ghost of Hamlet's father, in questionale shape, and its variety is infinite. In its various disguises it appears and struts the stage for a brief period, and vanishes, to be succeeded after a time by another emanation.

We are moved to these thoughts by the recent experience we had of a misguided stock salesman who approached us with the idea of selling us some stock. This stock was in a company which is putting on the market what the salesman described at different times to be a world beater, a sure-fire winner, and a scientific bobby dazzler. Apart from the fact that an editor belongs to a class who never have any spare money, this particular salesman had no chance of selling us stock in such a proposition. The inventor modestly claims that his apparatus will save at least 50 per cent of the fuel consumption of any boiler it is applied to. We intimated that if this was so all the interested parties needed to do was to take the apparatus up to the University and have it tested and their fortune was made. There would be no need to look for capital. Capital would fall over itself looking for them.

The smoke consumer occupies about the same position in engineering as Lydia Pinkham's Pink Pills do in medical science. Everyone we have seen can bring testimonials from dozens of satisfied users, but none we have seen yet have been able to furnish us with a duly authenticated, scientific record of a test. Nearly all of them depend for success on the introduction of a secondary air supply over the fire or in the combustion space, and as in most cases the cause of smoke is too much air to begin with, they do not help matters much. Even when they succeed in diluting the smoke it is no evidence that combustion has been improved. Complete absence of smoke is not a proof of perfect combustion in a boiler furnace.

Just imagine the amount of money that could be made by any company or individual that could actually save 50 per cent of the fuel burned in a plant of average efficiency, and what a benefactor he would be to the race. As to the man who can save 50 per cent of the fuel in a plant running at 65 or 70 per cent efficiency—words fail us.

Boiler Economy

IN ANOTHER part of this issue a correspondent writes about the old subject of fuel economy, and gives his own experience. He stated that in the plant where he worked he reduced the fuel consumption by one half and the number of boilers in use from three to one. In his letter he does not give details of the methods pursued, but we have invited him to do so, for the benefit of others.

This subject of fuel economy, while an old one, is ever fresh, fresh, and is being presented to countless men every day in a very vital way. Their ability to understand the subject and to achieve results measures their ability to retain their positions, or attain higher ones. The encouraging part of the matter is that practically every man has a chance to produce results, as there is hardly a plant in existence where some degree of betterment cannot be attained.

The large plant, which is usually well supplied with the necessary instruments, and opportunities for determining just exactly where losses are taking place, affords the best opportunity for attaining ideal conditions. On the other hand, it is the small plant where there is usually a noticeable absence of these aids to economy, where the greatest amount of improvement may be achieved by the man who really wants to get after it. The use of a draft gauge alone, which he can make from a gauge glass and a six-inch rule, will afford him valuable indications of the condition of his furnace and boiler settings. By means of a square box which will give him a means of accurately measuring the coal used he can compare results under different conditions of damper settings and thickness of fire carried, while a careful noting of the amount of coal dropping through the grate bars will show whether he is using the right type of bar for the quality of coal he is supplied with. Choosing the most favorable time for cleaning fires, careful attention to feed pump regulation, and a strict watchfulness on the physical condition of engines and auxiliaries will make a wonderful difference in even the smallest plants. All these things can be done by the careful fireman and engineer in the course of his daily duties, and the results will show very quickly.

The day of the happy-go-lucky man who is merely content to keep the plant running is fast approaching its end, if it has not already reached it.

LEADING ARTICLES IN THIS ISSUE

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Progress in New Equipment

THE NEW DIAMOND VALV-IN-HEAD SOOT BLOWER

AN ENTIRELY new principle has been introduced in soot blower design. The valve, controlling the individual unit, has been incorporated as an integral part of the head.

Let us for a moment briefly review recent developments in this important branch of power plant practice. The past few years have witnessed on the part of engineers everywhere, a marked growth in appreciation of the importance of rapid, thorough, mechanical removal of soot from the heating surfaces of steam generators. Coal and labor have constantly advanced in price. At the same time there have been unprecedented demands upon the boiler capacity of practically every boiler plant. The situation has called for systematic study of every factor affecting combustion. This analysis has proved the mechanical soot blower to be one of the best paying investments in the boiler room.

A large measure of the success of the mechanical soot blower has been due to the constant improvement in design and construction. Among the improvements of the past few years are the following:

1 The introduction of calorized metal for the protection of the blower elements from oxidation at high temperatures.

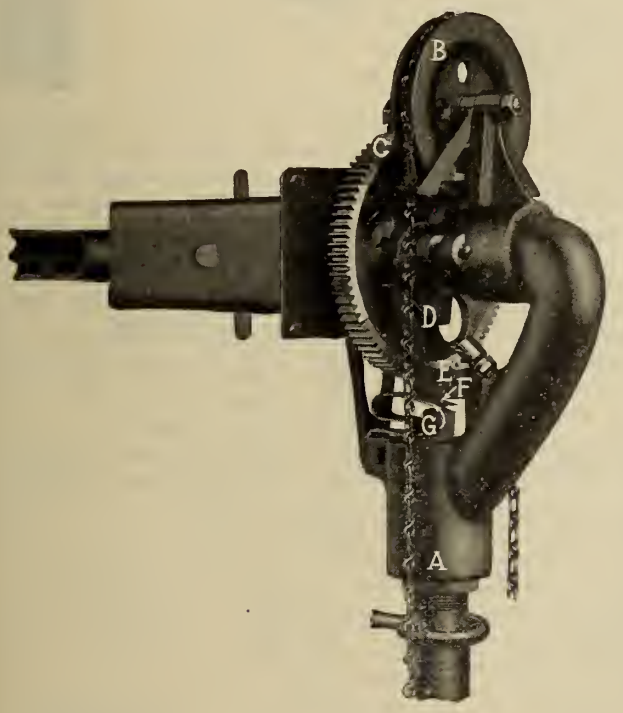
2 The adoption of nozzles of a Venture section to secure the highest possible velocity of the stream jets.

3 The development of special processes for welding these nozzles in place.

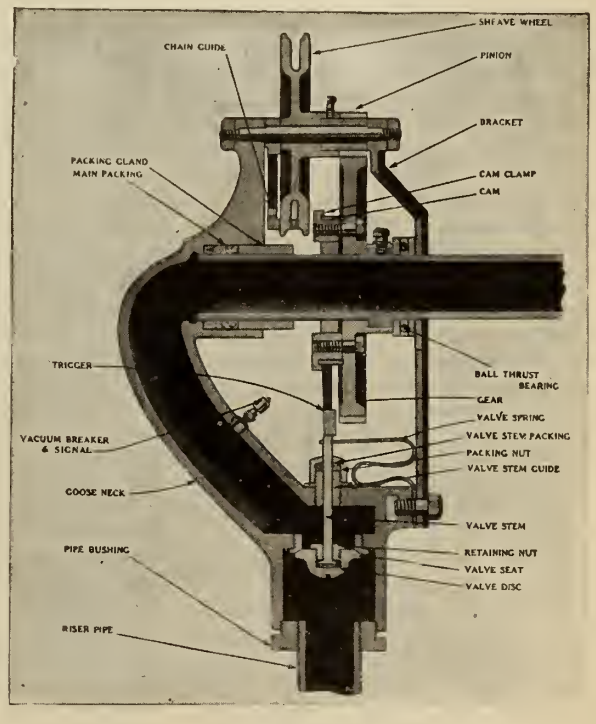
4 The designing of steel bearing to support the blower elements.

5 The introduction of the vertical header system of piping.

The successes heretofore registered have proved a spur to further efforts. Hence, we have the new Valv-in-head soot blower, manufactured by the Diamond Power Specialty Company, of Detroit, Mich.



General view of the apparatus.



Sectional View of the blower.

Head Constructed On New Principle

The Valv-In-Head soot blower is provided with a special Monel valve of the poppet type, placed at the base of the gooseneck. This valve takes the place of the globe valve which has always heretofore been installed (at a distance of two to fifteen feet or more from the head) in the riser pipe leading from the main header.

The special valve just referred to is located at the point marked "A" in the illustration, Figure 1.

The unit is operated in the following manner: The main control and drain valves which are the only independent valves on the soot blower line, having first been opened, and all piping drained and heated, dry steam fills the line to the entrance of the individual valve at the base of the gooseneck "A". The sheave wheel "B" is then revolved by pulling the chain. This turns a small steel cut pinion gear (not visible in the illustration). The small pinion engages the large gear "C" which is fixedly mounted on the blower element. As the gear is revolved, it operates a cam "D" which causes the lever "E" to press down the steam stem "F", causing the valve to open at a predetermined point in the revolution. After the gear has been further rotated, the cam "D" releases the lever "E", allowing the steam pressure to close the valve at a second predetermined point in the revolution. As steam leaves the line, the spring "G" holds the valve closed.

Construction of Valve

The valve is made with the Monel metal disc and seat. Both the steam and

its retaining nut are made of nickel steel. In order to secure extra hardness, which insures durability, the end of the stem is heat treated. A special feature is the provision of a guide on the seat, which permits leaving the stem loose in the disc so that the valve will always seat properly. The entire construction is such that the troubles common to globe valves, such as "wire-drawing," leakage, etc., are almost entirely eliminated. Disc and seat are readily accessible so that they may be removed easily for regrinding or renewal, should occasion ever require

As the tendency towards high pressure and superheat is very marked in modern power plant design, the Company manufactures a special body Valv-in-Head soot blower for such boilers as require this type of equipment.

Cam and Lever Construction

The movement of the cam is positive, assuring complete automatic opening of the valve at each operation. The cam and the clamps which hold in place are made of steel. The length and relative position of the cam is individually determined for each unit at the time of the installation.

The valve lever, which is also made of steel, is designed with a ratio of two to one, and as the reduction of the gears is ten to one, the opening of the valve is as readily accomplished as is a lever with a power arm of one hundred inches and a resistance arm of five inches was used. The spring is made of chrome vanadium. As the spring is away from heat, it always keeps its tension.

Vacuum Breaker and Signal

A very unique idea has been successfully worked out in the Valv-in-Head blower. Each head is provided with a vacuum breaker for the purpose of preventing the suction of furnace gasses into the blower element during the periods when steam is off the unit. In the present head this vacuum breaker has been designed in the form of a small brass whistle.

During the time the soot blower is in operation, the whistle sounds, furnishing both an audible and a visible signal, so that there is no opportunity for the operator to leave steam on the unit for a moment during which he is not revolving the blower, without the fact becoming readily apparent to any one in the vicinity.

Chain Guides

An important feature of the Valv-in-Head blower is the provision of guides to prevent the chain from slipping off the sheave wheel. It is not always convenient for the operator to stand directly under the unit, and the use of the chain guides enables him to operate the blower from any convenient point, without facing the posibility of having to hunt up a ladder in order to replace the chain on the sheave. The chain guides, in common with many other parts of the head, are made of steel.

A very marked step forward has been taken in the design of the Valv-In-Head soot blower, through the provision of a ball bearing to relieve the friction caused by the thrust of the unit, due to steam. As will be seen from the cross section of the head, this ball thrust bearing is located directly back of the steel wall bracket which supports the blower element. Its presence relieves friction so completely that the Valv-in-Head unit turns as readily when the steam is on as when off.

Floating Features Of The Valv-In-Head

The necessity for some means of eliminating the binding of soot blower units resulting from movement of the boiler tubes under the forces of expansion and contraction, is now generally recognized. An important developement in connection with the Valv-In-Head soot blower is the wall-box, with floating mechanism, which provides a means of taking care of any shifting of position of the blower element without causing dislocation of the wall-box, cracking of brick work, or expansion strains on soot blower head and brackets.

Elimination of Condensate.

One of the most important results of the use of the Valv-In-Head blower is the practical elimination of the possibility of water entering the portion of the soot blower inside the boiler. With the independent valve type of soot blower, the valve is located anywhere from 2 to 15 feet or more from the head. This means that condensation will inevitably take place when the valve is admited to the cold line. The water thus formed is driven through the soot blower head and into the blower element.

In addition to the condensate thus formed in the line a more serious possibility is that a small leak in the valve will cause water to form in the pipe before the valve is opened. When this occurs, a solid column of water may be built up in the riser pipes and carried over the boiler when the valve is opened.

The presence of this condensate in the hot blower element is apt to cause warping and its discharge on the boiler tubes may cause the soot to pack, forming a gummy mixture hard to remove.

With the Valv-In-Head system, any condensate in the main supply line is discharged through the drain pipes before blowing begins. There is, therefore, no water below the valve which can be carried into the blower head, and the radiation area in the head itself is so small as to be negligible. Hence we have practically complete elimination of condensate from the blower element.

VICTOR DAMPER REGULATOR

The accompanying illustrations show the damper regulator manufactured by the Atlas Manufacturing Co., New Jersey, U.S.A. and known as the Victor Damper Regulator No. 3.

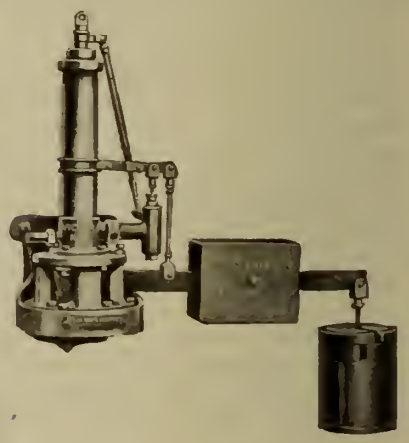
Installation

The regulator is furnished mounted on a cast iron bracket, which should be bolted to the wall adjacent to the boiler. The control piston should be connected to the damper with chain over pulleys, so that the damper is held wide open when the piston is down. The damper should then be counterbalanced so that it will close on an upward movement of the piston.

The water supply should be taken from the cold water line and connected to connection A (shown in illustration).

The steam pressure connection should be taken from the gauge line or boiler header and connected to the diaphragm at B (shown in illustration).

The discharge connection should be run from connection C on the pilot valve (shown in illustration) and run to any



convenient drain or to the ash pit.

By referring to the cut it will be noted that the direction of the water current is indicated by the arrows. The water pressure enters the regulator through the inlet A, passing to the pilot valve, then to the bottom of the control cylinder through port D. It also passes to the control cylinder on top of the piston through pipe E into the hollow piston stem and into the control cylinder through holes F.

The pilot valve stem I is of spool form with the upper head passing over port D. when above the port permits the water to pass into the bottom of the cylinder, and when below the port permits the water to escape from the bottom of the cylinder into outlet C.

By referring to the cut it will be noted that the area of the top of the piston is reduced by an amount equal to the cross-sectional area of the piston stem, whereas the area of the bottom of the piston is larger. We therefore have two opposing forces pushing against opposite sides of the piston, the constant pressure acting against the lesser area on top of the piston tending to force it down and the variable pressure from the pilot valve tending to push it up. Therefore when pressure is admitted to escape from the bottom of the cylinder the constant pressure forces it down.

Explanation of the Compensating Attachment

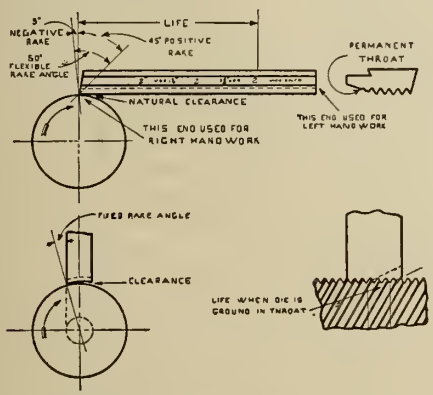
When the steam pressure under diaphragm G, is sufficient to raise lever H, the pilot valve stem I, is pulled up by lever J, swinging on axis K, this per-

(Continued on page 38)

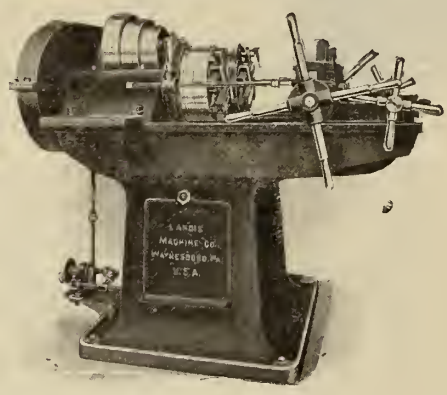
Landis Threading Machines

Standard Labor-Saving Equipment

Landis Bolt and Pipe Threading Machines do better work in less time because of the distinctive design of the Landis Chaser, which operates in the same manner as a lathe tool. Placed at a tangent to the work it allows the machine to operate at a higher speed than is possible when a hobbed type of die is used.



The diagram illustrates the main characteristics of the Landis Chaser as compared with the hobbed type die. It shows the long life of the Landis Chaser, and the fact that both right and left hand threads can be cut with the same set.



These are some of the special features that will help you lower the cost of production. Landis Thread-Cutting Machines are considered standard equipment by leading manufacturers, whose hardest jobs they handle with complete satisfaction.

We are the Canadian Representatives and our nearest Branch will gladly send detailed information.

IF IT ISN'T HERE WRITE US

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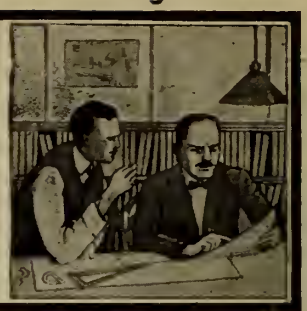
OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered



WORKING OF INJECTOR

Question: Why will not an injector work when it is hot?

Answer: One of the conditions of successful working of an injector is that there shall be enough water passing to condense the steam. If the injector gets hot or the feed water to the injector is hot, this cannot take place and the injector stops working. A pump will not handle water if that water is hot enough to vaporize in the pump cylinder. The same thing applies to the injector. When the steam issues from the jet and its pressure is converted into velocity, its pressure falls below that of the atmosphere, and the water is forced up the suction pipe by the pressure of the atmosphere. If the water is at a temperature which corresponds with the boiling point at the pressure existing in the injector, it will vaporize, and thus defeat the condition of having sufficient water present to condense the steam.

* * *

WHAT IS THE ECCENTRIC

Question: What is the relation of the eccentric to a steam engine?

Answer: The eccentric performs the important function of giving motions to the valve gear, which gives steam distribution to the cylinder through the slide or poppet or drop gear valves, as the case may be. The eccentric is really a form of crank, but is made in the form of a disc or cam. This disc is keyed on the crank shaft of the engine, eccentric to the shaft, and it is this fact that has given the eccentric its name. The distance of the eccentric centre from the crank shaft centre is the throw of the eccentric, and its position in relation to the crank is its angle of advance.

* * *

HORSE POWER OF A BOILER

Question: How do you get the horse power of a boiler?

Answer: The horse power of a boiler is obtained from the rate of evaporation of the water. The standard boiler horse power is the evaporation of 34.5 lbs. of water from and at 212 degrees per hour. Boilers are rated for horse power on the square feet of heating surface, a horizontal return tube boiler having 15 sq. feet per horse power, a water tube boiler having 10, and a locomotive boiler 12.

* * *

STEAM PUMPS AND FLUE GASES

In answer to a question on steam in pump cylinder in July 20th P.H. it is stated that the steam is at boiler pressure up to the end of the stroke. I can not understand how this is possible in a well proportioned pump operating under proper conditions?

In answer to "A Combustion Question" it is stated "on the other hand air leaking in the setting cooling the gases down and producing a low flu temperature." If this air leakage takes place near the furnace of a water tube boiler in any part of the sitting of a return tube boiler the result is a higher flue temperature.

It might be interesting to know the views of other engineers on the two questions.

R. McLAREN.

* * *

HYDRAULIC TESTS

I have lost much of my faith in hydraulic tests since reading the artirle by Mr. Stroymeyer in the July 5th Power House. Is there such danger when the test is from 50 per cent to 100 per cent above the working pressure? Should the hammer test be used both before and after water testing? What pressure do you recommend to test at when using water? Express in per cent. above normal working pressure. Could the cracks spoken of in the article be as strong when exploded as when tested. If not why did water at a little higher pressure do so much damage that did not come to light when the greatest load was on it but did some months later?

C. F. PYE,
Wesley College,
Winnipeg.

The usual practice is to make the hydraulic pressure about 50 per cent. above working pressure. Personally, we have always been in favor of careful inspection to determine the condition of a boiler, and against the use of the hydraulic test for anything but a determination of tightness of riveting and workmanship after execution of repairs. In the case of a new boiler, the hydraulic test will show tightness and also if there is a weak spot in the design or material it will usually be shown if the test is carried out properly. The mere putting on of a water test to a certain pressure and then releasing the pressure after a certain interval does not give any information about the condition of the vessel tested. In making a test from which it is required to take deductions concerning the condition of the material careful measurements should be taken before and after the test, to ensure that there has been no permanent distortion. Regarding the hammer test, this is a somewhat ambiguous term, for there are many different ideas of what constitutes a hammer test. We have seen a man take a 14-lb hammer and deliver some pretty hefty blows to the shell of a boiler under hydrostatic pressure, with the idea of testing it. It certainly did test it, but it is not a practice to be recommended. As to the ordinary tapping of plates with a light hammer, it makes little difference when that is done. We do not believe there is any man living with an ear sufficiently delicate to distinguish the difference in sound given by a plate that has wasted a fractional amount when i is tapped by a hammer. There are of course places where the hammer test can give indications of wasting, but these indications must be carefully verified by drilling before any certain verdict can be given.

We remember a case of the misleading nature of the hammer test method in determining conditions. We were making an inspection on a B. &. W. boiler, and on examining the short nipples between the bottom back headers and the mud drum, one or two of them gave indications of being suspiciously thin, by the feel of the hammer. We called the chief engineer into the back end, and passing him the hammer, asked him to try the nipple. He also thought it thin, and trying one or two others, came to the same conclusion. He wanted then to have them all removed and replaced, but it was decided instead to cut out the one that seemed the worst, and see just what it was like. This was done and that nipple was practically as good as the day it was put in. A hammer test will not reveal grooving, nor will a hydraulic test but a careful examination will.

You may take a piece of metal and subject it to a steady stress which is very close to its elastic limit, and it will sustain that stress indefinitely. However, if you take the same metal and subject it to an alternating stress of the same nature, or it will fail in a comparatively short time. A boiler is designed with a factor of safety of 4.5 to 5. which means that its working stress is only one fifth of its ultimate breaking stress. However, its elastic limit of the metal from which it is made, is only about 2½ times the working stress, and in course of time, the

elastic limit will be decreased. If then a stress of double the working pressure is put on the metal by a hydraulic test, it may well happen that the elastic limit will be reached, or even passed, and while no indication is given to the ordinary observer, the metal is left in such a state that a very few more alternating stresses will result in failure. That is why the boiler in the case mentioned by Mr. Stroymeyer withstood the hydraulic test but failed soon after.

* * *

BOILER ECONOMY

As the Course of Instruction has now concluded I would like to see a description of the ways and means of handling coal to the best advantage. When you see the dense black smoke pouring from the stack you know coal is going to waste, as smoke, soot, and poor heating surface usually go together. Why not educate the men who have to burn this coal, that costs so much and is decreasing in quantity every year?

I took a plant where three boilers were being operated, and in less than four months I was running the same plant and same load on one boiler and using only half the coal, but I want to know more about economical combustion. C. F. P.

There has been a considerable number of articles in the recent past on this subject but we think our correspondent's suggestion a good one. In the meantime will our correspondent give us a detailed account of the methods used by himself in effecting such a great improvement inhis own plant?—Editor.

* * *

TAIL END RODS

I would like to ask readers of the Power House the following question. Why is it that we hardly ever see tail end rods on horizontal engines? I know a few of the local objections that are entertained by designers and engineers. Of course on marine work I can quite understand why they are not in use on any vertical job, but I think that horizontal jobs above a certain diameter, say fifteen inches, should be fitted with tail end rods.

The above is my own opinion, and I would like to hear from readers of Power House, to find out their opinion.

T. WALSH,
Port Au Port, Nfd.

* * *

THRUST IN CONNECTING ROD

Referring to the article on this subject in the July 20th issue and previous issues, the contention of Mr. McLaren is perfectly correct, and the mistake was ours. It is perhaps unusual for a technical paper to make a mistake in a matter of this kind, but it is highly important that having made a mistake that we should promptly admit it and rectify the error, for our readers must not be misled.

We wish to thank Mr. McLaren for his efforts in pointing out this error, and several correspondents whose letters cannot be published for lack of space.

If there is any cause for gratification over this matter, it is in the fact that so many of our readers evince such an interest in the "Question Box," and we hope indeed that should we ever make another error that we shall have the critics down upon us with their utmost force.

Full and free use of the question page can tend only to the benefit of all those who use it, and the more the better. We can assure all of a fair field and no favor.

* * *

EFFICIENCY OF ENGINE

Question:—A steam engine of 120 H. P. drives a D. C. generator, the capacity of which is 250 Amps for 24 hours at 240 volts. The efficiency of the generator is 88 per cent. What is the efficiency of the engine.

Answer:—We are afraid from the way the above question is written, that our correspondent is not very clear on the subject of generator and engine efficiency. The capacity of a generator is measured in Watts, or Kilo watts, which is the product of volts × amperes. It is not affected by the length of time the generator is running. The generator in question is evidently of a maximum capacity of 250 Amps. at 240 volts, that is, 60,000 watts or 60 K. W. It is only the discharge of a battery that is reckoned in amperes × time or ampere hours. If its efficiency is 88 per cent. it would deliver at the switch board 60 × .88 or 52.8 K. W. The mechanical efficiency of the engine will probably be about 90 per cent. The actual mechanical efficiency of the engine can be found by dividing the indicated horse power as found from the indicator diagram, by the actual capacity of the generator, or by the brake horse power.

* * *

POWER FROM WOOD REFUSE

At a recent agricultural exhibition in England many different British makers of suction gas plant were shown, some of them in operation driving engines. They ranged from 2 to 65 horse power, the largest making gas from saw mill refuse, bark, shavings, or other wood waste, and the smallest using charcoal. The big plant takes only from two and a half to three and a half pounds of wood per brake horse power per hour, according to the quality of the wood refuse. The little one is mounted on its engine on a wooden truck so that it forms a complete portable power plant. Visitors to this exhibition were struck with the high class workmanship of this equipment which will be a boon to farmers and foresters in parts where charcoal is available.

Gelinas and Pennock Reg'd, Engineers, of 207 St. James Street Montreal, have recently been appointed sole Canadian agents for the Cokal Hand Automatic Stoker, made by the Cokal Stoker Corporation Chicago.

10,000
Indorsements

Whenever a manufacturer replaces a cumbersome bucket or float type of trap for the simpler, compact, more modern Sarco Steam Trap, he automatically indorses the greater efficiency of the Sarco. And many manufacturers are doing that very thing every day.

As a good example, there's du Pont—the mighty du Pont of explosives—the E. I. du Pont de Nemours Company. This great company, wise in the ways of success, has over 10,000 Sarco Steam Traps saving money by conserving steam and coal.

Why has du Pont installed the Sarco? Easy; there are two reasons. One is: good judgment on the part of the du Pont engineers and buyers. The other is: good service on the part of the Sarco.

The Sarco costs but one-third the price of a clumsy bucket or float trap, and renders better service. It is minus all the claptrap of unnecessary levers, gauges, packing and stuffing boxes, yet it is literally a valve, a bypass, a check valve and a steam trap all in one. Goes in as an elbow, too.

Du Pont engineers realized the economy of the Sarco. They know that it is cheaper to put in a new Sarco complete than to repair a worn out float in a float trap. A float costs about $12.00, whereas a new Sarco, one-inch size, costs only $9.60 net.

If you would like to satisfy yourself, we'll gladly send you a Steam Trap Sarco on 30 days' free trial.

Booklet J-12 an full informatio sent on request.

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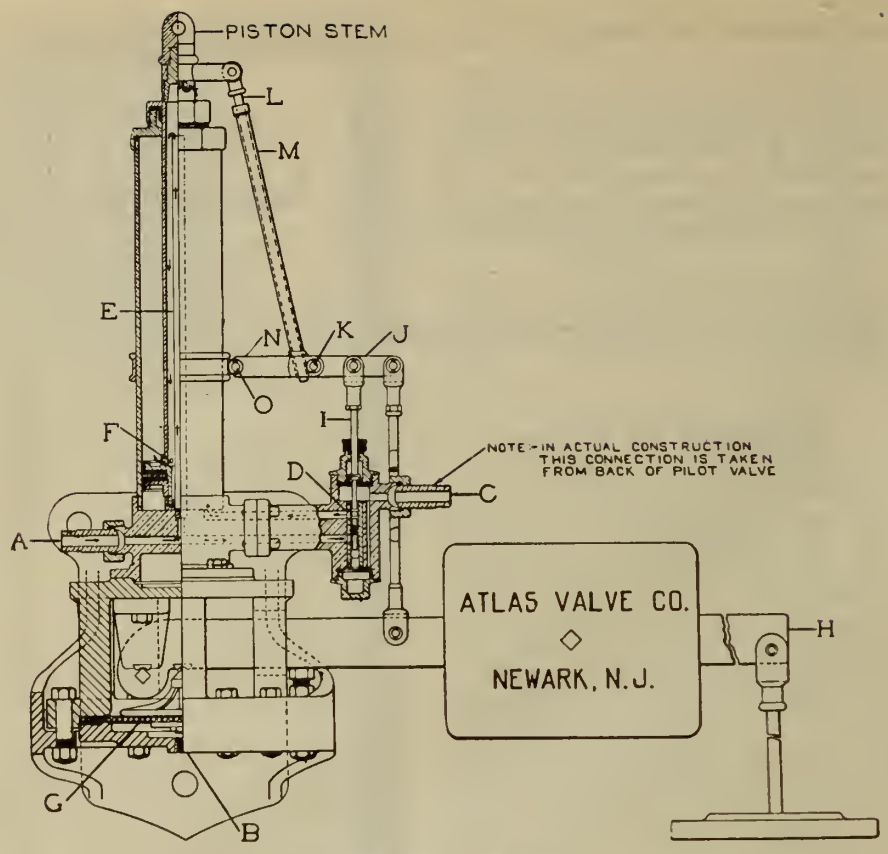

Sectional View of Regulator

VICTOR DAMPER REGULATOR

(Continued from page 34)

mits the water to pass into the bottom of the control cylinder and force the piston up.

As the piston moves up rod L is pulled upward in sleeve M, which is rigidly attached to lever N, swinging on axis O. As the point where rod L is attached to the piston stem travels in a straight line, the angle at which sleeve M stands is lengthened and to meet this longer angle sleeve M must swing outward, which depresses axis K on the end of lever N. This pushes pilot valve stem I down so that the upper head of the stem covers port D, and shuts off the water supply to the bottom of the control cylinder which checks the upward travel of the piston.

When the steam pressure falls, lever H lowers and pulls pilot valve stem I down, so that its upper head is below port D. This permits the water in the bottom of the control cylinder to escape into outlet C, which allows the constant pressure on top of the piston to force the piston down.

As the piston moves down rod L, sliding into sleeve M, shortens the angle at which sleeve M stands and to meet this shortened angle, sleeve M must swing inward, which raises axis K, and pulls pilot valve stem I up so that the upper head of the stem covers port D, and shuts off the water discharge from the bottom of the cylinder, which checks the downward travel of the piston.

The importance of the compensating attachment cannot be overestimated as it acts as an intermediary medium to counteract the movement transmitted to the pilot valve by the steam pressure under the diaphragm, which balances the position of the damper on intermediate pressure changes, and permits the damper to be fully opened or closed only on extreme boiler pressure variations.

NEED OF INSPECTION

The Editor, Power House:

Enclosed is a clipping from a local paper and it shows the need of some one to inspect such boilers and report to those higher up. I would suggest that if it could be done one man should be appointed in each county to inspect such boilers as these, the inspection fee to be paid by the owner. It might help to improve the care given by those in charge.—N.E.A.

"The corporation's road roller has been inactive for the past day or two on Thames street north. A crack in the boiler is held responsible, and in turn, carelessness is held responsible for the crack. A boiler expert from Woodstock was working on the machine yesterday, and stated positively that nothing but carelessness could be held responsible. He had to chisel through the thickest boiler plate he has encountered in a lifetime of boiler work in an effort to remove the cracked portion. Within he found the scale and sediment of long term of carelessness. "This sedament should be cleaned out every two weeks" said he. "In this boiler there was a great thickness of scale. The water could not get to the plate, with the result that it soon burned and cracked. Every boiler should be washed out at least every two weeks. That prevents the accumulation which means boiler ruin. This boiler had the best material in it I have ever worked with, and with any kind of care, would have lasted a lifetime."

One of the workmen present stated that the idea had been advanced that the roller is used only about two weeks in every year, and there had not been the proper precautions taken on that account.

"It makes no difference how long it is used in a season. It should be washed out every two weeks while in use. It should then get another cleaning out when put away for the year. Unless this is done, it cannot be expected to be in good shape when taken out the following spring."

A large patch has to be attached to the outer surface of the boiler, and it was expected that this would have been completed by Thursday evening. The expert was asked what it would cost to put the boiler in good shape, flues, boiler and all.

"I would say roughly that it would cost over a thousand dollars" said he. "Of course I have not gone into the matter, but I would say that with a fair degree of certainty. That is the price of carelessness. This is an excellent boiler and would have lasted indefinitely had it been given proper attention. There are too many bosses in council jobs, and too many having the care of the roller in their hands. There should be some one who would see that a corporation machinery of this kind was given the attention it should have, and there would be money saved for the corporation."

The above is an example of the need of inspection of all boilers, whether large or small. This is a case evidently where every one's job is no one's job. It would be interesting to know how many cases like this occur in a year.

We had occasion to inspect several boilers of this type some years ago in an Ontario brickyard, and the internal condition of these boilers was little short of disgraceful. The owner was profoundly surprised when we mentioned the necessity of cleaning them and said they had never been cleaned during his ownership, which extended over several years. He had recently had them insured, hence the inspection.

The Armstrong Cork Company, of Pittsburgh, Pa., have issued a small folder entiled "Four Reasons" which describes the use of the Nonpareil High Pressure Blocks and Cement manufactured by the company. These are designed for insulation of all high temperature equipment.

Mr. H. T. Day, of Mirlees, Bickerton & Day Ltd., who are the manufarturers of Mirlees Diesel Oil Engines, is at present in Canada on an extended tour. The firm Mr. Day represents have a large number of engines installed in various parts of Canada, and Mr. Day purposes visiting each installation during his trip.

Some Advice to the Boiler Attendant

These Notes are Taken from the Annual Report of. Mr. C. E. Stromeyer, of the Manchester Steam Users Association, England. They are Worth Reading as Coming from a Very High Authority

*By HERBERT R. REYNOLDS

Economy

THE coal bill for a Lancashire boiler amounts to from $4000 to $6,000 per annum. Careless stoking may easily increase this cost by a few hundred pounds, and is sure to throw much extra work on the stoker. The best stokers do the firing rapidly but judiciously, keeping the firedoors open for the shortest possible periods.

The best results, with a minimum of labour, are attained when each boiler discharges a light smoke. Absence of smoke, except from coke or smokeless coal, indicates that much heat is being wastefully blown up the chimney in the form of useless hot air, which air has been admitted in excess above the grate or through brickwork cracks. Dense smoke is also wasteful and occurs most frequently with over-worked boilers. It is produced in furnaces which are nearly choked with coal, or whose doors or grids are insufficiently opened. Most fuels require some extra air through air grids in the doors immediately after firing, but when the coal is burnt through, the extra air supply should be reduced.

Air Leakages through cracks in brickwork are always wasteful. Such cracks would show up as black lines if the boiler outsides, including blow-off pits, were frequently whitewashed.

Mechanical Stokers.*—The leading types are the sprinkler stoker, the coal stoker, and the underfeed stoker. They should be maintained in perfect working order. Their designs are based on the experiences gained with particular qualities of coal, usually dirty slack, and unsatisfactory results are obtained if the particular quality is not used. Mechanical stokers which may have been intended for impure coal would burn away or melt if very clean and, therefore, very hot coal were used. Financially it is an unsound principle to aim at a superlatively high efficiency, for this is associated with intensely hot flames and costly repairs for wear and tear.

Dangers.—A boiler may empty itself overnight, or if the blow-off cock or feed valves are leaky, the boiler may empty itself while steam is being raised. It is, therefore, imperative that the water-guage glass should be tested before starting fires, and should be watched while raising steam; it should also be carefully watched during working hours, even if automatic feed-regulators and low-water level alarms or safety valves are fitted, for if these appliances should stick fast, the boiler may empty itself without warning, resulting in bulged furnaces. In the event of shortness of water every effort should be made to cool the furnace plates, the most effective means being to turn on all available feed water and to cool the fires by covering them with ashes or green coal. The furnace doors should also be opened and the dampers partially closed. Modern furnaces being made of steel, rarely burst when bulging, and it is only in cases of prolonged and serious overheating that a collapse leads to an explosion.

Automatic Feed Regulators are a source of danger, for whereas without them a collapse cannot well take place unless the feed supply stops, the water level sinks, and the attendant neglects his duty, a collapse will follow as a matter of course if any single part of the mechanism of an automatic Feed-Regulator gets out of order.

Corrosion

The chief cause of internal corrosion or rusting of boilers and economisers is the unavoidable presence of the oxygen and carbonic acid which are dissolved in all feed waters. This air is liberated wherever the circulation is sluggish, as in economiser pipes and in the bottoms of boilers. It attaches itself in minute bubbles to the metal and corrodes it, particularly if the plates are not covered with scale. The most effective preventive for this kind of corrosion is the continuous addition to the feed water of vegetable extracts like tannin, or of caustic soda or caustic lime. The caustics neutralize the carbonic acid gas of the air in the water, whereas the vegetable extracts destroy the oxygen gas. The addition of a little caustic lime to very pure feed water has the further advantage of leading to the formation of a thin protective scale.

Internal Corrosion may also be due to the presence in the boiler water of neutral salts, for they lead to galvanic action. Hence brackish waters, which contain common salt and chloride of magnesia, and softened waters, which generally contain sulphate of soda or other soluble impurities, are also sometimes corrosive. Comparatively small traces of any of these salts in the feed water rapidly concentrate in a boiler, unless it is occasionally blown down a little, for during working hours the entire volume of water in a Lancashire boiler is evaporated, and has to be renewed by the feed in about five hours†. Thus if the feed contains 14 grains of salt per gallon, or 1-50 per cent., the boiler water would, after 1,000 hours steaming, contain 4 per cent. of salt. With locomotive and winch boilers the density increases much more rapidly.

Scale or Incrustation, as well as mud sediments, are introduced into a boiler with the feed water in which they are dissolved, and from which they separate out as the water is being heated or evaporated. Most hard scales contain sulphate of lime (plaster of Paris) which can be converted into softer carbonate of lime (chalk), by the addition of soda ash to the feed, but no treatment of water in the boiler will reduce the amount of deposit; it will at best alter its character and facilitate cleaning. The slight trace of grease, which mere filtration will not remove from condenser waters, is the cause of slow but often serious bulging of furnace tubes.‡

Water Softeners are vessels in which the feed water is mixed with certain chemicals in suitable proportions, causing the scale-forming impurities and grease to be precipitated. These precipitates have to be removed both by settling tanks, and by filters. They should be of large dimensions, otherwise the precipitates may be carried into the boiler. The oftener the feed water is tested for hardness and the addition of chemicals regulated accordingly, the more thorough will be the purification. If possible, the water should be treated warm.

Water Softeners which are not properly worked can do more harm than good, even to the extent of increasing the deposits in boilers and attacking the gun-metal fittings.

Water Softeners do not remove soluble salts, such as common salt or sulphate of soda. On the contrary ,they add either the one or the other of these salts if the feed water has permanent hardness. Water softeners are the most effective devices for removing all but the very last traces of grease from condensed waters.

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* For water-tube boilers the following remarks apply:—

Brickwork Wastage. The intense heat of mechanically stoked fires and the contact with the brickwork of fuel which contains lime leads to rapid wasting away, entailing heavy brickwork repairs. It is, therefore, advantageous to use a clean coal and to restrict combustion near the brickwork sides.

Mechanical Stokers for water-tube boilers are generally of the chain grate type. They are designed to burn small coal and usually do this economically, but, as their repairs grow very expensive if they are not kept in working order, all defects should be made good as soon as noticed. With chain grates the thickness of the bed of fuel and the rate of travel can be varied at will and the draught can also be regulated by the dampers. It is, therefore, possible to obtain either very good or very bad economic results. The best conditions will have been attained if the fuel has just finished burning when it reaches the end of its travel, the grate being covered with fuel from end to end; but this is not always possible if the duty of the boiler is irregular.

Dangers. On account of the large amount of heat stored in the brickwork of water-tube boilers, especially if they have been worked heavily up to the time of stopping, there is always the danger of the water in the boiler being evaporated while standing idle

† In a water-tube boiler the water will be renewed in about two hours time.

‡ In water-tube boilers scale and grease ought not to be allowed to exist.

External Corrosion usually occurs under damp boiler coverings, walls and seatings, ashes and flue dirt. Ashes should, therefore, not be slaked against boiler fronts, leakages of shells and furnaces should be stopped, and drippings from roofs, steam pipe flanges, or drain cocks should be prevented from falling on boiler coverings. Any suspicion that there is a leakage under a boiler covering should be acted upon at once.

Flue gases are heavily charged with acids and moisture, especially if steam jets are used in the furnaces. This moisture and acid readily settles on the cold lower parts of economisers and corrodes them. This corrosion can be prevented by warming the feed to 120o Fah. if steam jets are used in the furnaces, otherwise a feed inlet temperature of 100o Fah. will suffice.

Idle Boilers should be kept in a warm condition, especially if they are full of water ready for immediate use, otherwise dampness will cause serious wasting on the outside. If a boiler is to be laid off for any length of time, it should be scaled, washed out and dried, trays with unslaked lime should be placed inside, and all openings should be closed so as to keep out the damp air. Boilers which are not closed up in this manner often waste away more rapidly than those which are in use.

Economizers are as a rule built of cast iron. This is an unreliable material and occasionally pipes fail from the date of erection. As the water is relatively cold no explosions result. Such failures would be real explosions if the economiser water were in a boiling condition. Therefore, always open the bye-pass of an economizer when the feed does not pass through the economiser.

Boiler Inspection

A boiler must be completely opened out and all scale removed before inspection. The boiler coverings should also be removed occasionally, and the seatings exposed, unless the inspector can satisfy himself by other means that there is no external corrosion.

In addition the boiler should be frequently overhauled, say after 1,000 hours steaming, if good feed water is used, or after 250 hours or less, if a sedimentary or corrosive water is used.* On these occasions mud and scale should be removed. Whenever possible, the boiler shell plates in the flues should be freed from soot and tar deposits, for these are amongst the worst known conductors of heat. It is for this reason that economisers are provided with scrapers which remove these deposits continuously.

Before removing the manhole covers of a boiler, at least one safety valve should be permanently opened, for, if there is either a pressure or a vacuum in the boiler, the manhole door may be blown off, or into, the boiler. The junction valve and the blow-off tap should be padlocked or otherwise secured, so that these cannot be opened while men are in a boiler.

Leaky cocks, valves, and joints should be made good whenever a boiler is laid off.

It is very desirable that candles and a chisel should be provided before the inspector arrives.

Steam Pipes

The opening of steam valves and drain cocks should be done carefully, as is proved by the fact that many steam-pipe explosions have occurred when one boiler attendant has been replaced by another who was unaware of the order in which the valves and cocks were opened and closed. The attendant should be quite clear in his own mind that wherever steam and water meet in a confined space there a water hammer may occur. The "singing" of kettles when just on the boil is due to numerous but minute water hammers. With high-steam pressures and large volumes of cold water in long pipes, the water hammers are so intense that they will easily fracture the strongest steel pipes If cracking noises (water hammers) are heard in pipes, their causes should be inquired into.

The attendant should take it for granted that all low-lying steam pipes, especially long ones, all low-lying bends junction valves, and all pipes between bulb valves are pockets in which water from 1in. to 1 1-2in. per foot of diameter, will condense in a range of pipes as soon as steam is turned into it. This water cannot be forced out suddenly, but must be removed slowly, and very often much water in a pipe helps to create a vacuum, and as there is then no outflow a fairly full pipe may be thought to be empty. A safe plan for coupling up a steam-pipe range is as follows:—

Open the Drain Cocks; these will either drain away the cold water or admit air, which, if a water hammer should occur, will soften the blow. Close the cocks before opening the steam valve slightly. After a time close the steam valve and re-open the drain cocks. These operations may have to be repeated several times.

Low-Lying Junction Valves, unless automatically drained, should not be drained or opened as long as there is steam pressure in the high level main.

Steam Traps of the expansion type admit air when pipes are cold, but neither these traps nor those of the floating type will drain a pipe in which there is no pressure, nor can they drain away the newly-condensed water. Therefore, if steam is turned on suddenly, steam traps cannot be expected to give protection. They should in any case be kept in perfect working order.

*For water-tube boilers read: say after 500 hours steaming, if good feed is used (sedimentary or corrosive water should not be used with water-tube boilers.)

169,000 W.W. OF TURBINES TESTED AT ONE TIME

The capacity of the Testing Room of the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company was taxed to capacity recently when 169,000 KW of steam turbine generators were on the test floor at the same time. Nearly 150,000 KW of this amount was made up of five turbines for some of the largest power companies in the United States. Reading left to right, these turbines are as follows:

35,000 KW turbine for the Hellgate Station of the United Electric Light & Power Company of New York.

25,000 KW turbine for the Virginia Power Company, Cabin Ceek, Va.

25,000 KW turbine generator for the Gold Street Station of the Brooklyn Edison Company.

35,000 KW turbine for the Calumet Station of the Commonwealth Edison Company, Chicago.

25,000KW turbine for the United Electric Light Company, Springfield, Mass.

10,000 KW turbine for the American Rolling Mills, Middletown, Ohio.

Other turbines on the floor are a 3,000 KW low pressure turbine for the New Jersey Zinc Company at Franklin Furnace, N. J., a 1,000 KW turbine for the Tupelo Cotton Mills, Tupelo, Miss.; a 1,000 KW turbine for the Mobile Light and Railway Company, Mobile, Ala.; a 2,000 KW house turbine for the United Electric Light and Power Company, N. Y., and a 2,000 KW turbine for Takata & Company, Japan.

BRITISH INDUSTRIES FAIR, 1922

The next British Industries Fair will be held in London and Birminham between the 27th February and 10th March 1922.

The British Industries Fair is open to manufacturers in all parts of the British Empire and buyers from all over the world are attracted. It affords an excellent medium for bringing manufacturers in direct contact with buyers, as only bona fide manufacturers are invited. The general public are not admitted.

Full details regarding the Fair can be obtained from H. M. Trade Commissioner at 248 St. James Street, Montreal, 260 Confederation Life Building, Toronto, or 610 Electric Railway Chambers, Winnipeg.

ANNOUNCEMENTS

Operation, construction and safety features of type A auto-starters are given in leaflet 1610-C, which is being reprinted by the Westinghouse Electric & Manufacturing Company. This leaflet describes in detail the auto-transformer, switching mechanism, the contacts, the overload relays, and many other features of this apparatus.

* * *

Storage Battery Mine Locomotives is the subject of leaflet 1888-A which has just been printed by the Westinghouse Electric & Manufacturing Company. This leaflet describes the applications of storage battery mine locomotives, and illustrates and treats on the Baldwin-Westinghouse type of apparatus.

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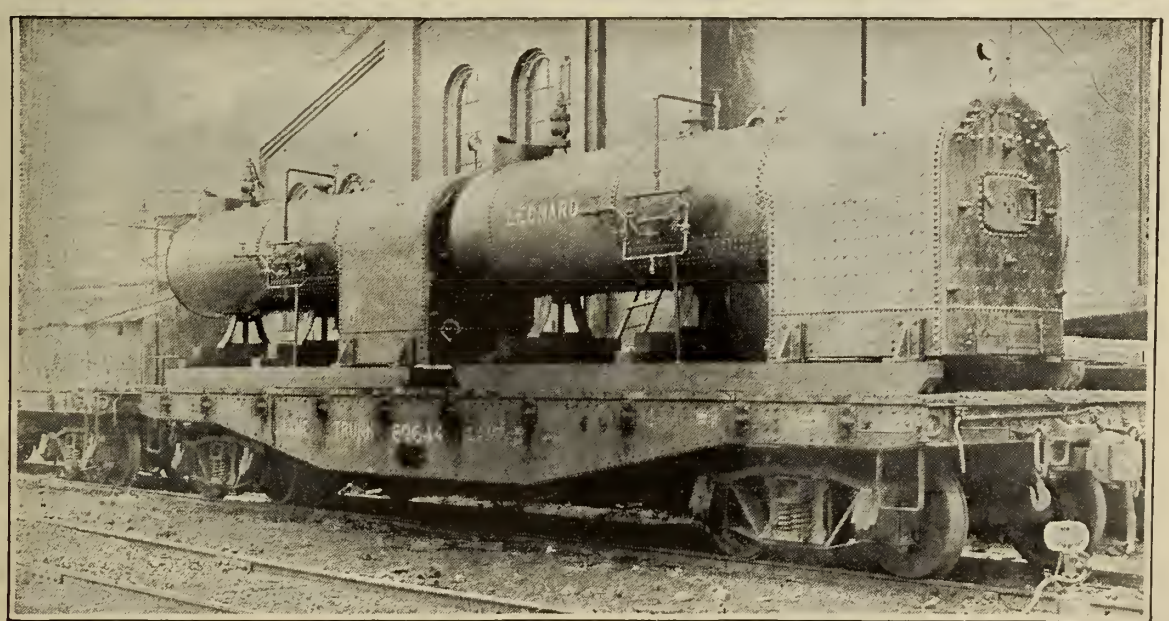

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Inglis Co., The John, Toronto.
Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Rochester, N.Y.

AIR METERS
Bailey Meter Co.

ALLOYS, BRASS AND COPPER
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Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

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Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
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Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ARCHES, BOILER AND COMBUSTION
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFINGS
Can. Johns-Manville Co., Ltd., Toronto.

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W. J. Brown (Tucks), Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.
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ASBESTOS PACKED COCKS
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W. J. Brown (Tucks), Montreal.

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Magnolia Metal Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Co., Toronto.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS, BRASS
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

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Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Philip Gies Foundry, Kitchener, Ont.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
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Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
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B. F. Sturtevant Co., Boston, Mass.

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Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLES
Jointless Fire Brick Co., Chicago, Ill.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILERS
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BOILER COMPOUNDS
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Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
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Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

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Jointless Fire Brick Co., Chicago, Ill.

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Beveridge Supply Co., Montreal.

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Babcock & Wilcox, Ltd., Montreal.
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Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto

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Johns-Pratt Co., The, Hartford, Conn.

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Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

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BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
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The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

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W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

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Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

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D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

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Mueller Mfg. Co., Ltd., The.

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Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Bovling Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

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International Chemical Co., Toronto, Ont.
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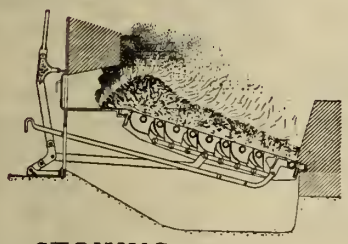
Can. Link-Belt Co., Toronto, Ont.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.

Stop Cleaning Fires By Hand

Fire Your Coal This Way

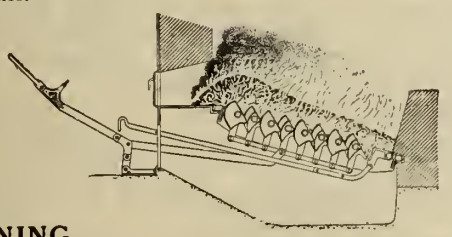


FIRING

Fresh coal laid on Front Gases must pass over fuel bed.

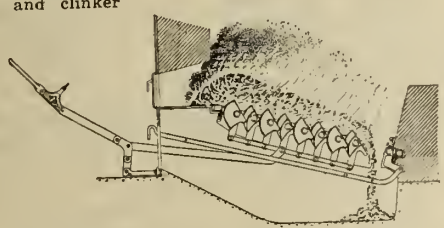
STOKING

Half throw of lever advances coked fuel evenly over stoker.



CLEANING

Full throw of lever and auxiliary discharge eliminates all ash and clinker at rear.



CoKal Hand Stokers save fuel, save labor and eliminate that hot, dirty, disagreeable job of cleaning fires. Also increase evaporation and efficiency.

Send for Illustrative Bulletin

GELINAS & PENNOCK, Reg'd.

207 St. James St., MONTREAL, P. Q.

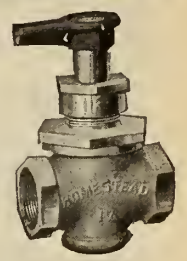
USE

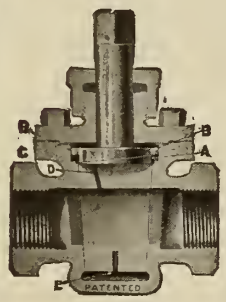
COKAL

HAND STOKERS

HOMESTEAD Quarter-Turn Valves

About thirty times as fast as globe or gate valves!





It takes from eight to ten turns of the wheel to open or close the ordinary globe or gate valve while a Homestead requires but **one quarter turn!** Think of the convenience, think of the time saved on any service where frequent opening and closing is required!

That's why HOMESTEADS have replaced globes and gates in hundreds of plants.

They are used for air, steam, water, oil, or acids and will keep your pipe lines absolutely tight.

HOMESTEAD VALVES are made in Straightway, Three-way and Four-way patterns.

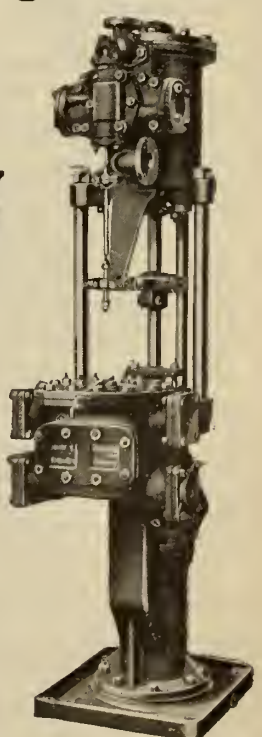
Write for catalogue.

Homestead Valve Mfg.Company

Homestead, Pa.

With the Single Gland

A high pressure pump for Marine and Land Service. It has only one gland on the ram to require packing.



HEPBURN

"Special" Vertical Ram

FEED PUMP

is the one pump to use where positive action with minimum attention and upkeep are required. It is an outside-packed type operating with positive Lever Valve Motion. The Pump Ram works in a brass Sleeve and the wear is evenly distributed as the weight of the ram and piston is taken by the water pressure. We are also makers of Vertical Engines, Compressors, Cranes, Cut Gears, and Iron Castings. **If interested write us.**

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Godfrey Conveyor Co., Toronto.
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Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.
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MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

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Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal Que.
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Frick Co., Waynesboro, Franklin Co., Pa.
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Northern Electric Co., Ltd., Montreal.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., Elkhart, Ind.
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M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
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COUPLINGS, SHAFT
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Smart-Turner Machine Co., Ltd., Hamilton.

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Smart-Turner Mach. Co., Ltd., Hamilton.

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MacKinnon Steel Co., Sherbrooke, Que.

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Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

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Can. Link-Belt Co., Toronto., Ont.
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MacGovern & Co., Inc., Montreal, Que.
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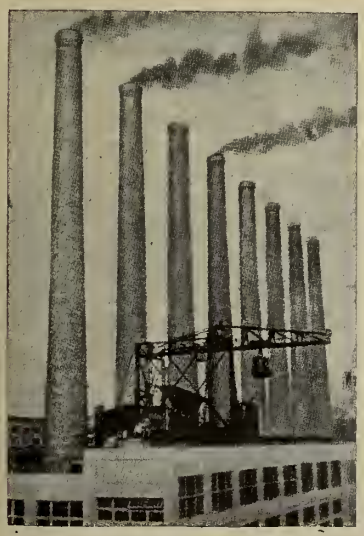


Eight Kellogg Radial Brick Chimneys 150 ft. by 7 ft., Corn Products Refining Co., Argo, Ill.

SOME KELLOGG CHIMNEYS

General Motors Inc., Oshawa— 175 ft. x 7 ft. 6 ins.

Ames Holden Tire Company, Kitchener— 175 ft. x 7 ft.

Dominion Power & Transmission Co., Hamilton—2-250 ft. x 12 ft.

Prest-O-Lite Company, Toronto— 110 ft. x 5 ft. 6 ins.

Peterboro Milk Products, Peterboro, Ont.— 90 ft. x 4 ft.

T. Eaton Co. Ltd., Hamilton— 125 ft. x 4 ft. 6 ins.

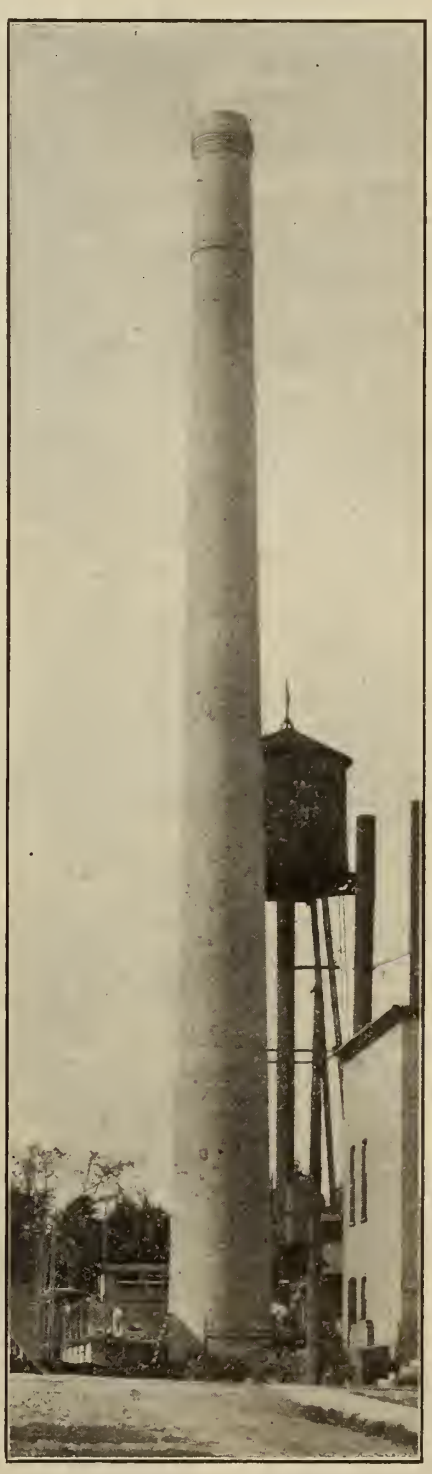
Canadian Woollens Ltd., Peterboro, Ont.— 90 ft. x 4 ft.

Sick Childrens Hospital, Toronto— 127 ft. 6 ins. x 5 ft.

Lever Bros., Limited, Toronto— 125 ft. x 7 ft. 6 ins.

Palmolive Co. of Canada, Ltd., Toronto, Ont.—150 ft. x 5 ft. 6 ins.

Wayagamack Pulp and Paper Ccompany, Baptist Island, Quebec— 250 ft. x 10 ft.



Kellogg Radial Brick Chimney, 145 ft. by 5 ft. Canadian Woollens, Limited, Peterboro, Ont.

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S. F. Bowser Co., Ltd., Toronto, Ont.

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Crane Ltd., Montreal
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
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PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

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Wm. B. Scaife & Sons, Pittsburgh, Pa.

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Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

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Page-Hersey Tubes, Ltd., Toronto, Ont.

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MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

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[illegible] Fairban[illegible]orse Co., Montreal.
Goldie & McCu[illegible] Co., Galt.
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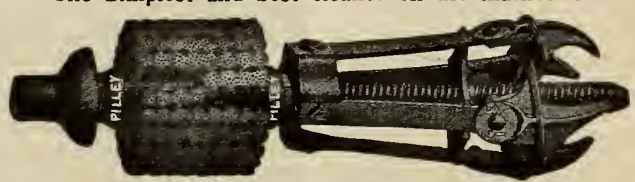

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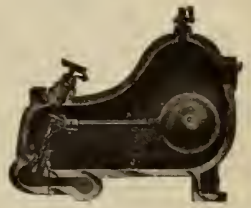

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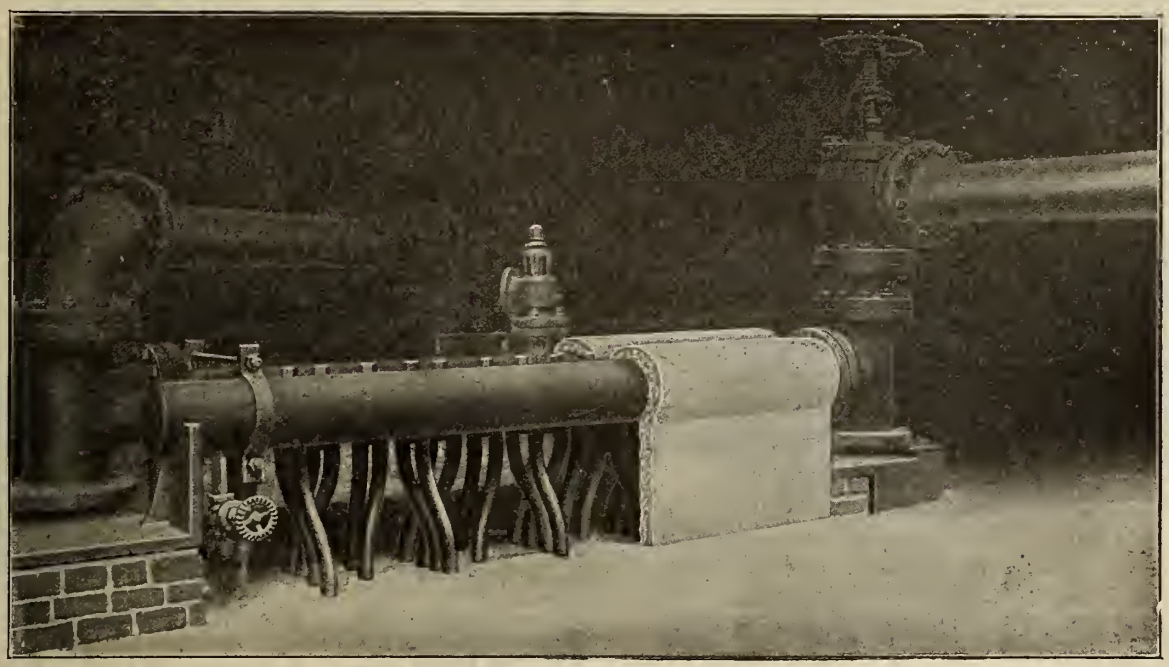

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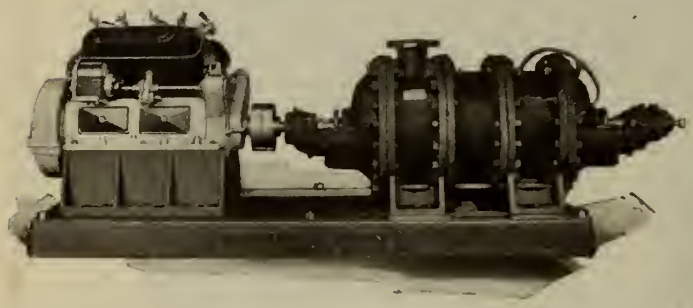

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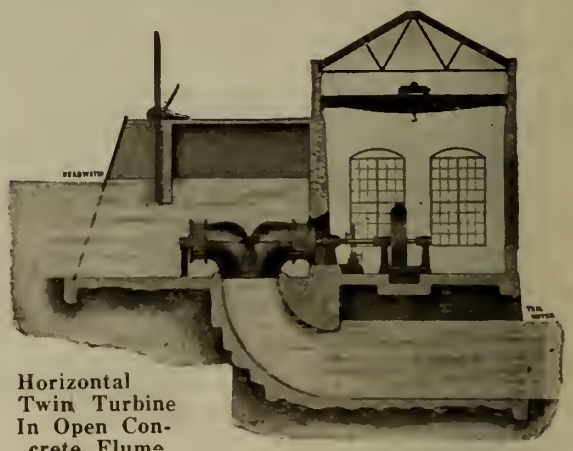

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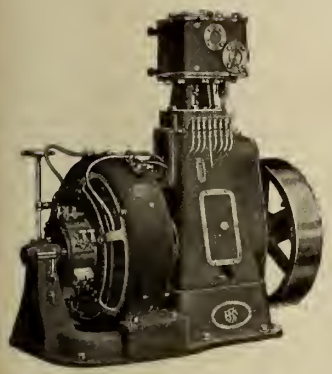

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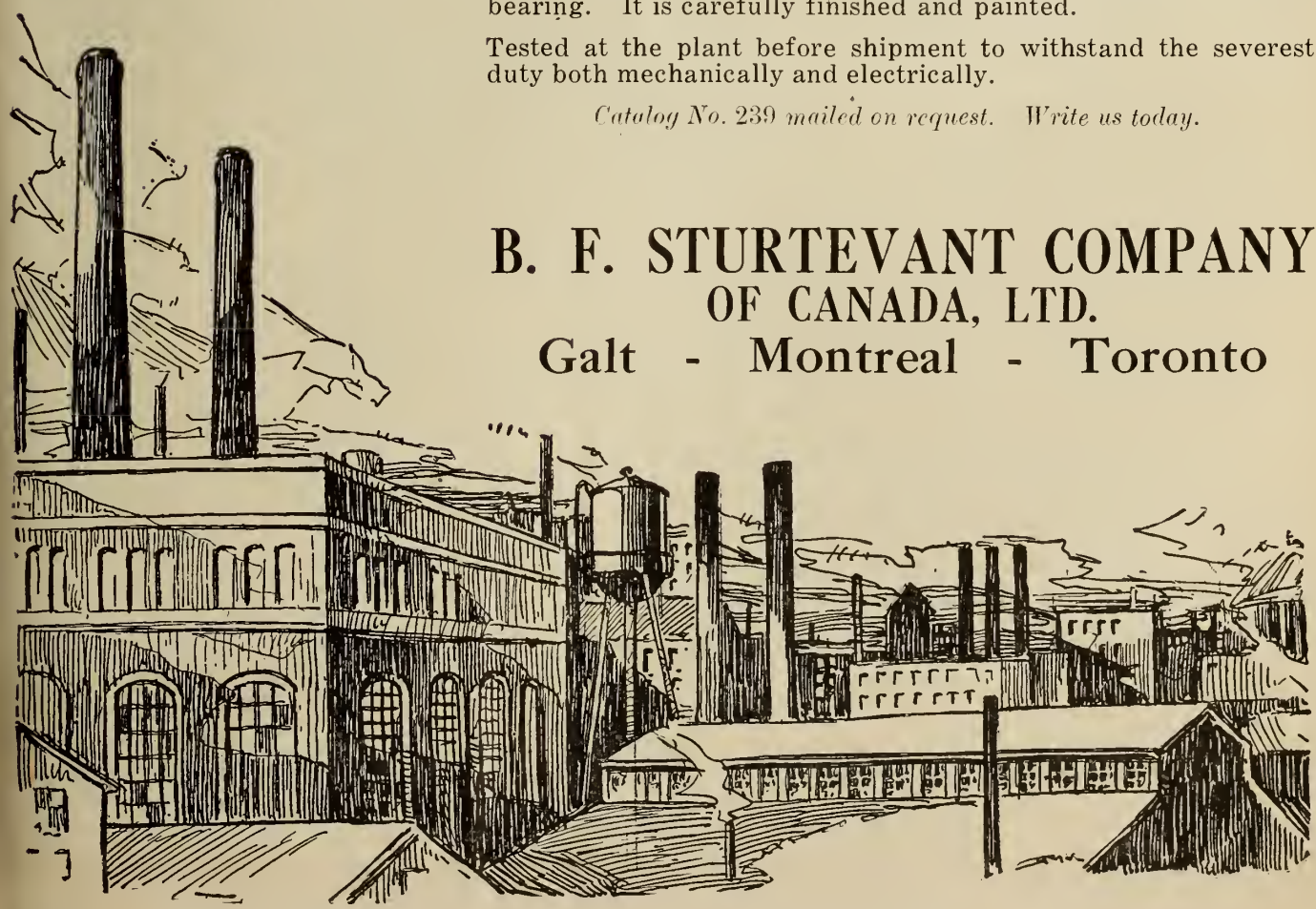

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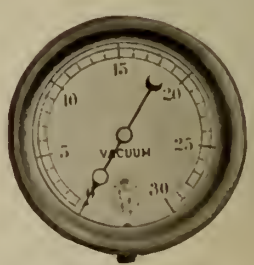

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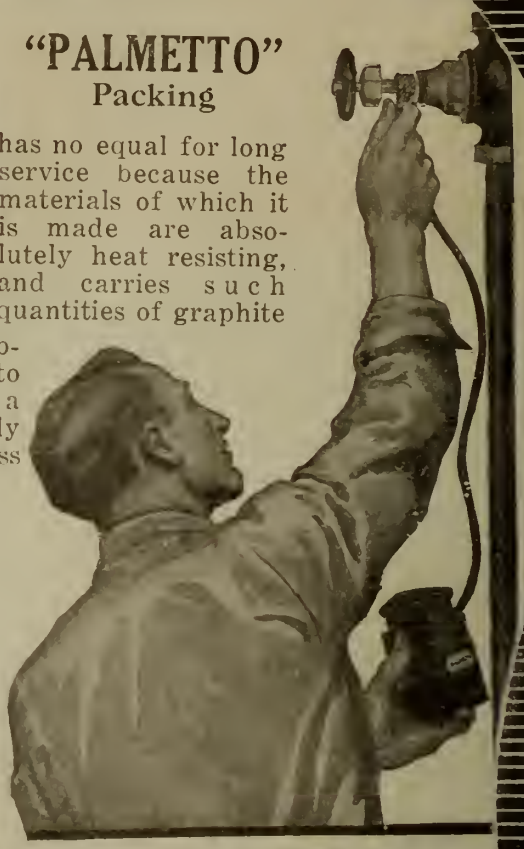

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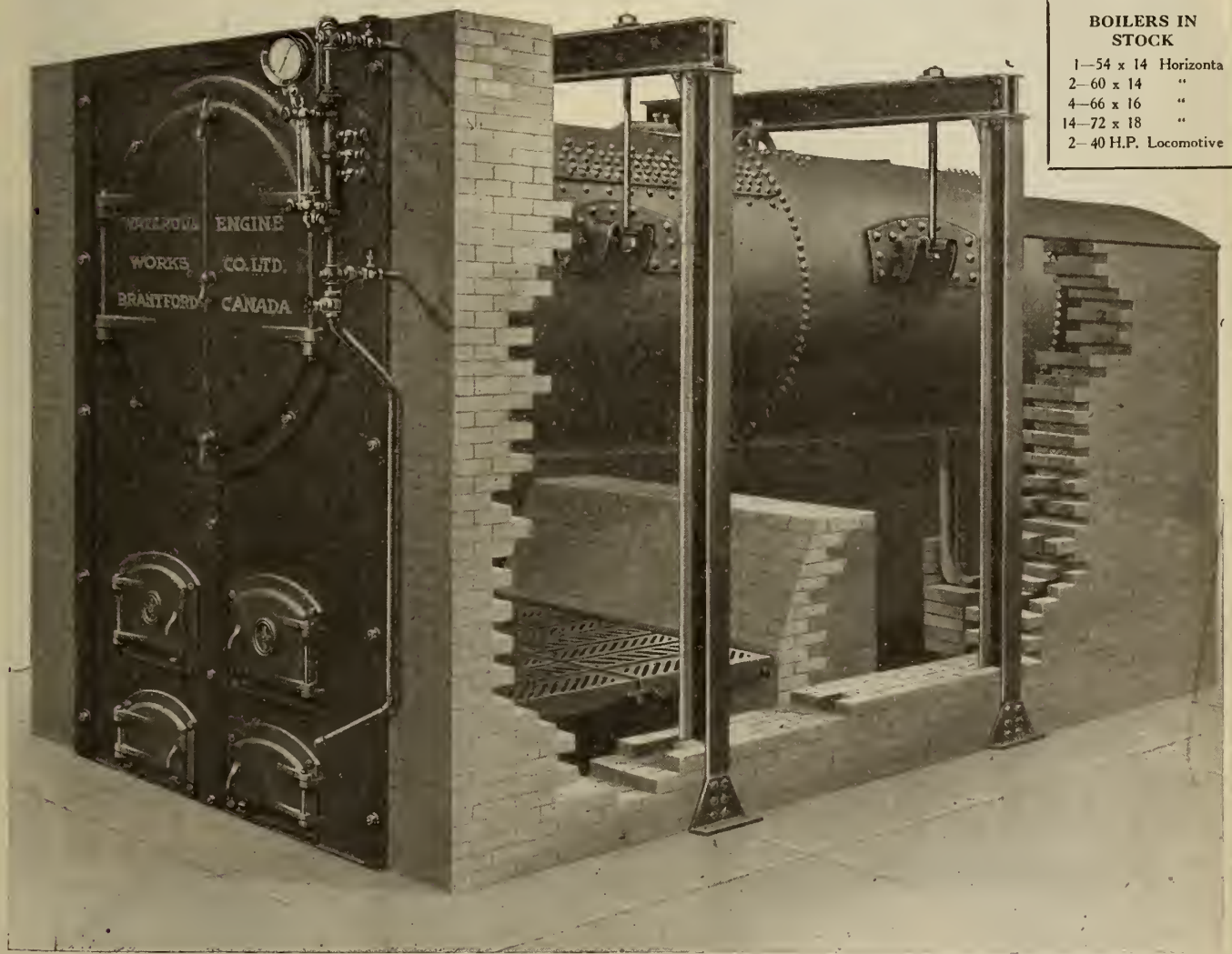

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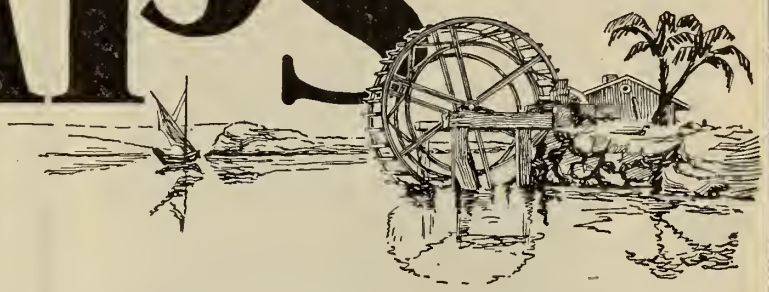
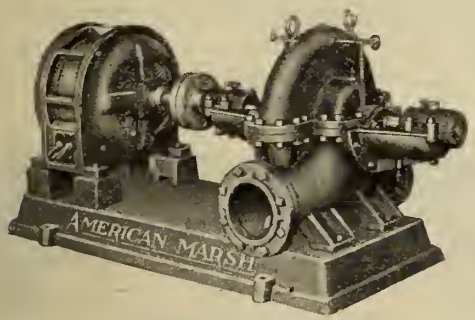
PUMPS



BY use of the ancient Sakieh a pair of oxen could keep ten acres irrigated throughout an Egyptian summer.

The Sakieh, or water wheel, was considerably more efficient than most of the other ancient pumping devices. Made to revolve by beasts of burden, and equipped with an endless chain of buckets, the Sakieh could raise 1,200 gallons of water 24 feet in one hour.

Modern American-Marsh Pumps have a capacity of from 5 to 5,200 gallons per minute. They are especially adapted to the solution of difficult pumping problems. They are made in both single and double suctions, solid and split case patterns.



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The American-Marsh line also includes Boiler Feed Pumps, Power Pumps, Air Compressors, Vacuum Pumps, Condensers, Deep Well Engines, Stock Pumps.

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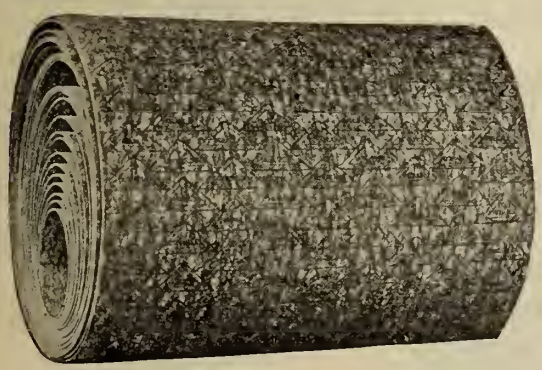

Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

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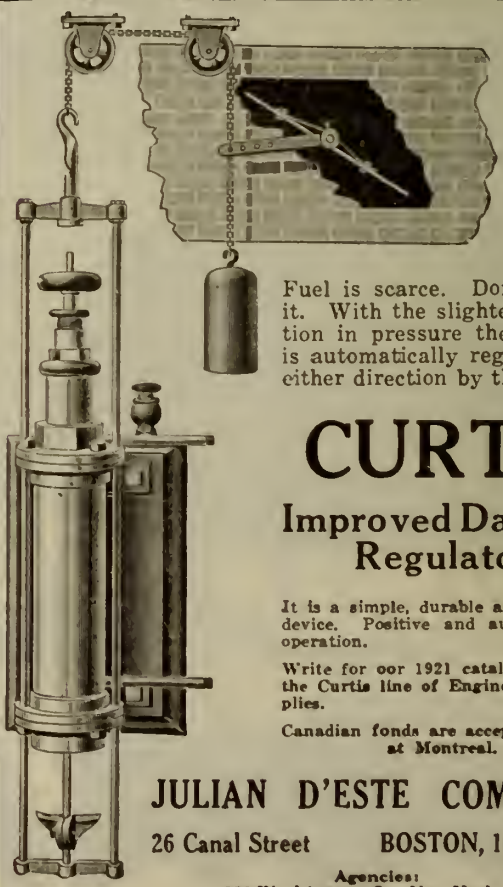

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Besides our other Fuel and Power Savers, we are now handling the following additional lines:

The Genuine SPENCER Damp Regulator

Recognized as the best for the last 35 years, and

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This indicator—the only flawless instrument of its kind made—is the original Indicator invented by the late J. W. Thompson, an engineer of international fame, and perfected by him after years of tireless experiment. His ability and brains become your ability and brains when you employ the American Thompson Indicator in your profession.

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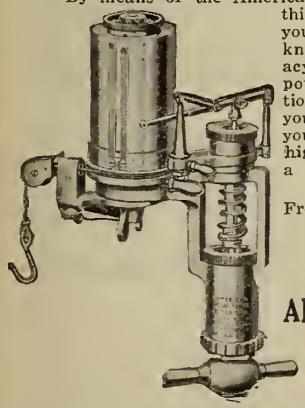

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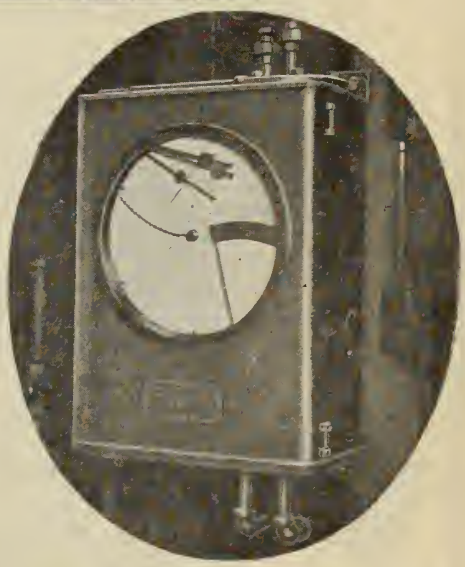
It Isn't the Coal You Burn

It's the POWER You Get that Counts



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are the connecting link between coal burned and power obtained. Wherever there are discrepancies—wherever more coal is burned than necessary Bailey Meters will show it. Bailey Boiler Meters indicate the individual performance of each boiler by showing the Steam Flow, Air Flow, and Flue Gas Temperature—all on one chart. Bailey Meters are easily installed. The charts are easily read. They save you money from the day they are put in. Bulletins for the asking.

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New Truths and Old Fallacies

Lubricating Quality—*Continued*

The test of Magnolia Metal at the Brooklyn Navy Yard by the United States Government was made, chiefly, in comparison with White Brass, a tin-zinc mixture, at that time used by the navy, but discontinued after this test.

The engineer officers in charge of test thought that it would also be a good time to try out a babbitt metal of the same composition as Magnolia but made in the conventional way of merely melting together the ingredients, without special foundry and graphite treatment.

The tests of these three metals were made with both water and oil lubrication on a machine with capacity up to 600 lbs. load per square inch.

In the test with water lubrication, which discloses the true intrinsic worth of metals, Magnolia developed a frictional co-efficient as low as 0.00080 and proved to be 200 per cent superior anti-frictionally to the "conventional" babbit and 1,100 per cent. superior anti-frictionally to the White Brass, the latter failing under a comparatively light stress, just as the Genuines did in the test by Doctor Torrey.

In report of this test mention is made of the peculiar property of White Brass in becoming pasty and crumbling when hot. As a result of this test Magnolia was recommended for use in the Steam Engineering Department of the Navy.

(Continued next month).

For copy of complete article:
"New Truths and Old Fallacies"
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Trouble-Free Service

There can be no loosening up in service because there is no deterioration at the point where the joint is made -- and the Heavy Iron Parts will not stretch or pull apart under strain or heavy pressure.

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Connections are easily made whether pipes are in or out of line.

YOUR JOBBER SELLS THEM.

Bronze to Bronze at the joint.

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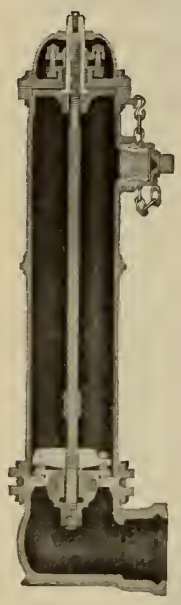

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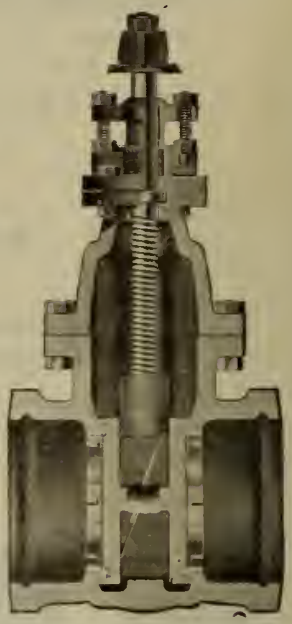

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Finally, many of the largest power plants throughout Canada choose D. K. McLaren's Belting to maintain their efficiency. And, after all, the service which this belting renders its users is the greatest proof of its quality.

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For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

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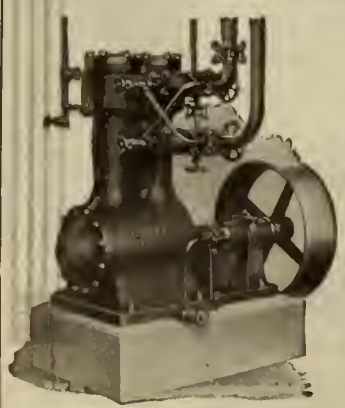

Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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Our Machines are in daily operation in Canada

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242 Beecher St. - - - Milwaukee, Wisconsin

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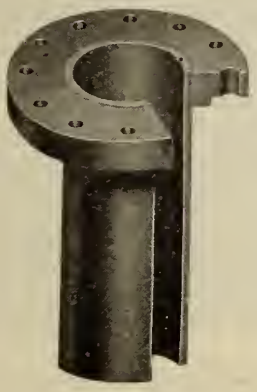

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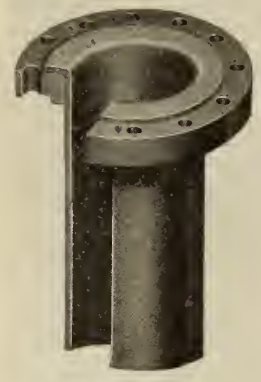

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SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs. the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

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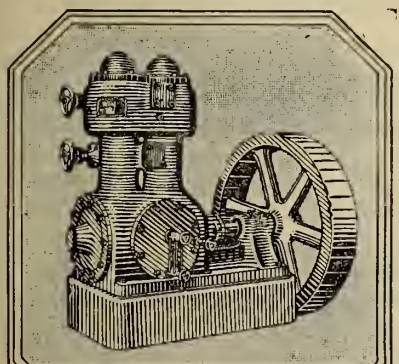

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The governing factor in the selection of Refrigerating Equipment, in most cases, is the reliability of the machine. Can it be absolutely depended upon to perform the work? A shut-down during the warm season is always annoying and often is an item of expense, due to loss of production or deterioration of products in storage.

York Refrigerating Machines have demonstrated their absolute reliability by more than thirty-five years of satisfactory service, which has given them a high reputation throughout the refrigerating field.

Ice and Ice Cream Manufacturers, Meat and Produce Dealers, Creameries, Dairies, Confectioners, Grocers and many other industries are using York Mechanical Refrigeration profitably in the production and marketing of high grade products. If you require Refrigeration in your business, we should be pleased to have you investigate the York System.

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(Ice Making and Refrigerating Machinery Exclusively)

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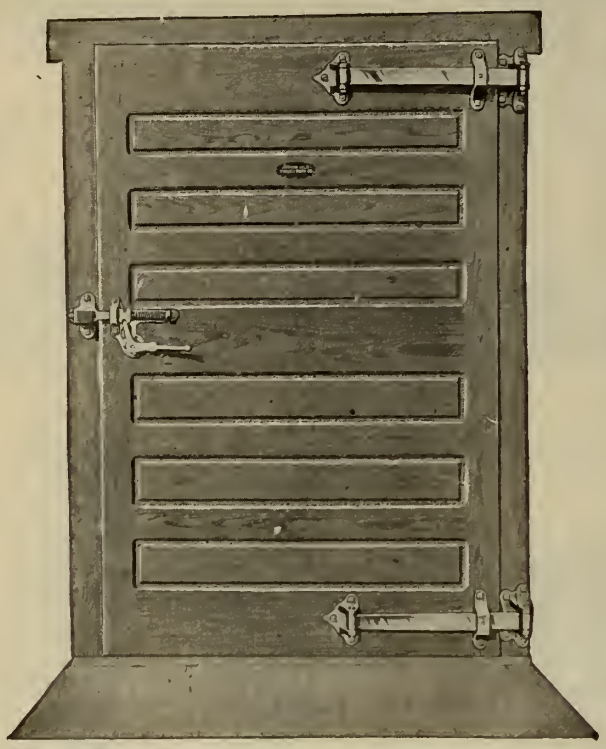
There is a YORK Plant to fit Your Business



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

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conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

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Cold Storage Plants - Smallest to Largest

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Ask for a copy of our List of Users covering 48 pages of satisfied customers -- also your copy of Ice and Frost.

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ICE MACHINERY SUPERIOR SINCE 1882

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There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

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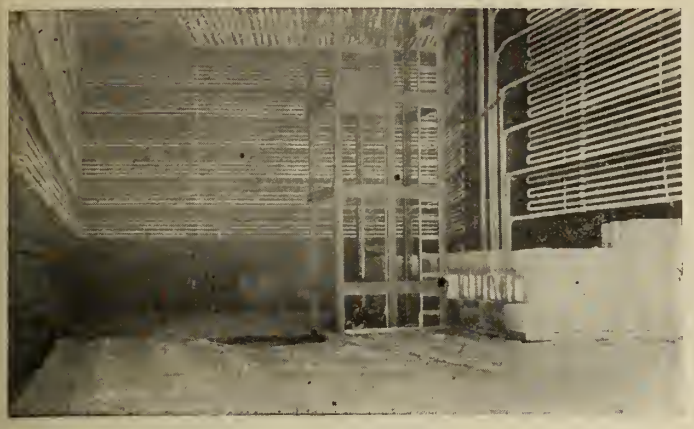


The 4-inch Nonpareil Corkboard in the walls of this ice storage is finished with mastic asphalt, ironed on at the factory. The roof and floor insulation are 6 and 5 inches thick, respectively. Independent Ice and Cold Storage Company, Shreveport, La.

Storage for Economy

Of course, an ice-plant can be operated without a permanent storage. But ice storages would not be built if they had not demonstrated that they are profitable. The fact is that an ice-plant without ample storage is operating at very low efficiency, like any other factory that is alternately idle and overloaded.

It is also possible to build an ice storage without insulating it with Nonpareil Corkboard. But it is significant that those plants which have most convincingly demonstrated that the storage of ice is good business *are insulated* with Nonpareil Corkboard. The reason is this: Ice can be stored profitably for long periods provided little refrigeration is required to hold the proper temperature. Now ice does not have to be cooled; all the refrigeration has to do is to remove the heat that leaks in through the construction. The better the insulation the less refrigeration will be used; hence, the quality and quantity of the insulation practically determine the cost of operation.

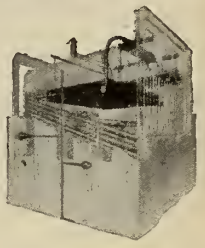
Ice storages are built for low cost operation; Nonpareil Corkboard is the most *efficient* insulation. They are built for permanence; Nonpareil Corkboard is the most *durable* insulation. They are built for profit; Nonpareil Corkboard is the most *economical* insulation. It is the recognition of these facts by keen-thinking ice manufacturers that accounts for the widespread use of Nonpareil Corkboard in houses like that shown above.

Without charge or obligation the engineering department of this company is at your service. Data, specifications, and estimates on the insulation of ice storages will be gladly furnished. If you are planning to build or extend storage space, don't fail to get the 152-page book, "Nonpareil Corkboard Insulation." It will be sent free on request.

Armstrong Cork & Insulation Co.
902 McGill Building, Montreal, Que.
11 Church Street, Toronto, Ont.

NONPAREIL CORKBOARD INSULATION
For Ice Storage Rooms

DIAMOND VALV-IN-HEAD SOOT BLOWERS



THE PRINCIPLE OF THE VALV-IN-HEAD SOOT BLOWER is so new and so different that its possibilities can hardly be adequately described.

Take for instance the matter of labor,—the new Diamond head effects a saving of fully 50 p.c. as compared to other types of hand operated units. Note how this is accomplished:

(a) The total time required for blowing is cut squarely in half.

(b) There is no walking back and forth from blower operating chain to valve—a single round trip completes the cycle of operations.

(c) Only one man is required, no matter how large the boiler. (With other types of blower heads two men are customarily employed on large boilers.)

Under these conditions the cost of labor becomes an almost negligible factor in the cost of operating the soot blower.

The saving in steam is just as pronounced, because every bit of steam does effective work in cleaning the boiler. Note how waste is avoided:

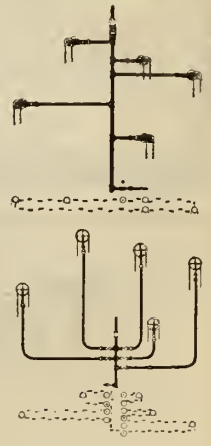
(a) No steam is discharged while the operator is walking.

(b) Steam jets are in rotation throughout the entire blowing period.

(c) Speed of rotation is controlled by gear reduction. No waste of steam occurs as the result of too slow or too rapid operation.

(d) Globe valves, essential to other heads, require many valuable moments to open and close, during which steam is wasted. The instant operation of the Valv-in-Head eliminates losses.

These are only two of eleven important advantages of Diamond Valv-in-Head soot blowers. Others include savings in pipe, valves and fittings, maintenance, gain in cleaning efficiency, etc., etc.
Every boiler needs a mechanical soot blower and you will save money by buying the best. Diamond Valv-in-Head blowers are adapted to all types of water tube boilers. On request our Service Engineer will go over your existing soot blower installation and advise whether it can profitably be replaced with the Diamond Valv-in-Head system. Ask for your copy of Bulletin 287 describing the new blower.



Saving steps saves steam Valv-in-Head means single round trip. No steam while walking. Independent valves mean steps retraced, steam wasted while walking.

DIAMOND SPECIALTY CO.

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

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Coal Handling Equipment

Makes coal storage safe and cheap. This equipment consists of a moving bridge traveling lengthwise of the storage space and a bucket trolley traveling crosswise on the bridge,—thus every square foot of storage space is covered with a minimum of movements and time. Capacity from 60 to 90 tons per hour. Low power costs.

Write or wire for particulars.

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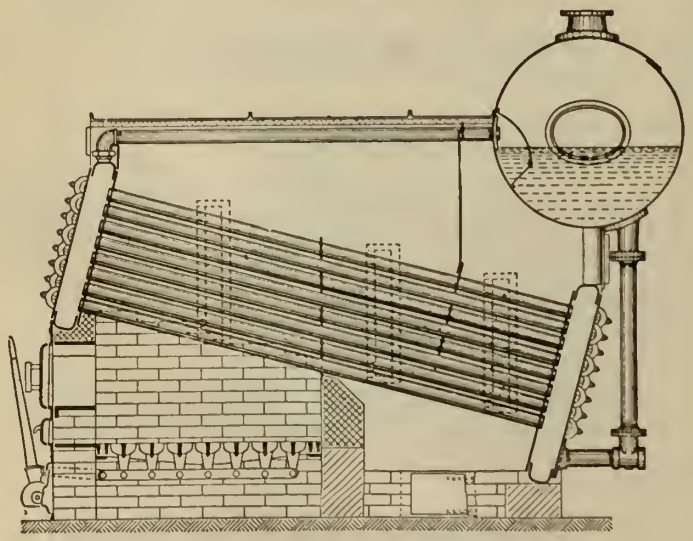

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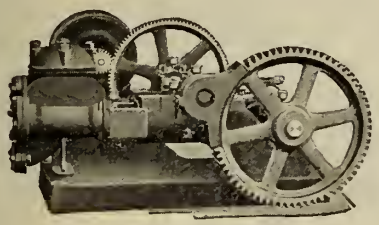

FIG. 7404

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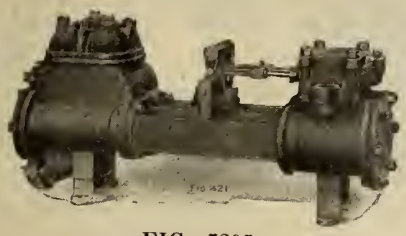

FIG. 7295

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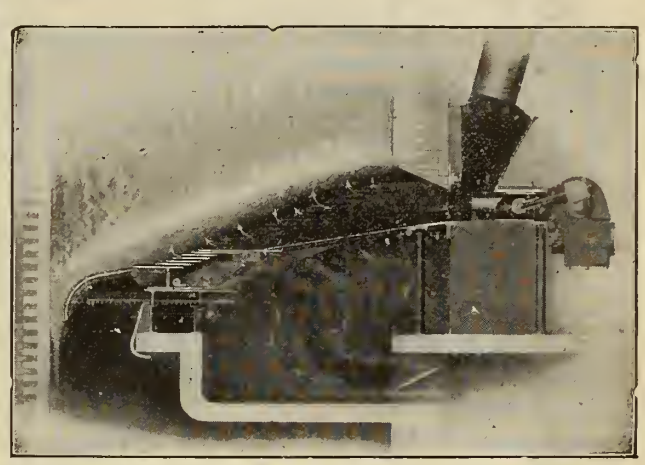

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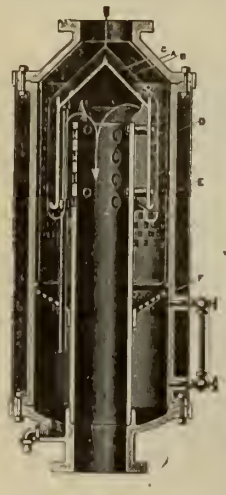

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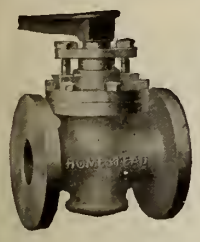

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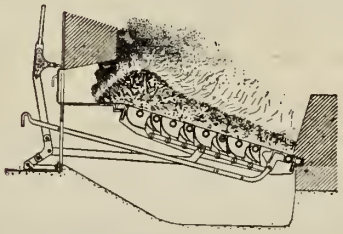

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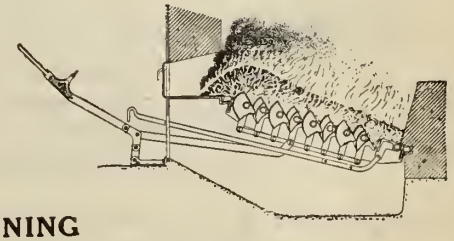

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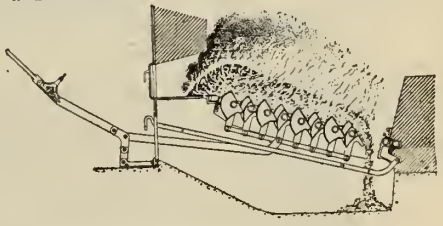

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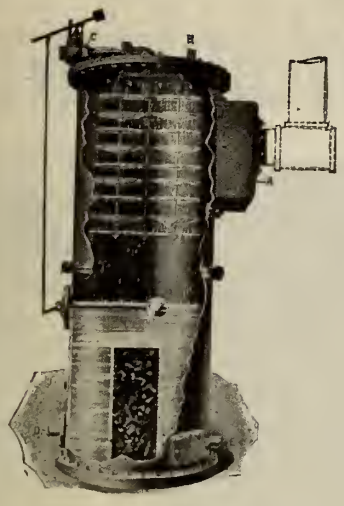

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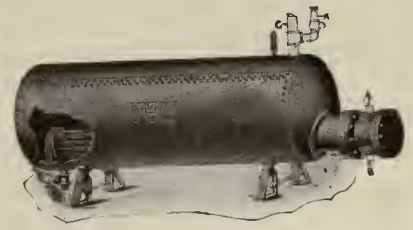

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The Treatment of Boiler Feed Water

This Article is the Continuation of the Article which Appeared in the Issue of August 5th and Carries the Subject on to Different Methods and Materials

By ROBERT JUNE

IN OUR preceding article we dealt with the nature of the various impurities in boiler feed water, and the operating troubles resulting from them. We have now to consider the various methods in use of treating bad water.

According to our previous outline, the neutralization or elimination of impurities in feed water may be effected by one or more of the following methods.

(b) Blow off.

1. By chemical means.
   (a) Boiler compounds.
   (b) Water softening plants.
2. By mechanical means.
   (a) Tube cleaners.
   (c) Filter plants.
3. By thermal treatment.
   (a) Feed water heaters.
   (b) Distillation plants.

Boiler Compounds

There are a number of boiler compounds in use, but the base of most of these is carbonate of soda, to which caustic soda is sometimes added and occasionally phosphate of soda. In addition materials containing tannin and starch are frequently added, with the object of coating the particles of precipitated matter so as to prevent their cohesion.

The use of boiler compounds is sometimes condemned as thoroughly bad practice, the following contentions being made; that mechanical difficulties prevent the maintenance of proper ratio between the amount of compound used and the volumn of water; that it is very difficult to control the treatment to take care of the changing analysis of the water; that adequate boiler compound treatment is very expensive; that compounds necessitate frequently blowing down the boiler to prevent an accumulation of sludge and sodium salts, which cause foaming and that moreover blowing down must frequently be supplemented by wahing out and occasionally cutting out the boiler completely to remove foreign matter.

Despite these criticisms, boiler compounds still find favor with many practical men, particularly in small boiler plants. When it comes to compounds, a great deal of care and attention must be paid to their selection and use. A great deal depends upon the attitude of the compound manufacturer. If he is willing to sit down and thresh out your problem with you, you may receive satisfactory service at a cost that is not prohibitive.

It is all simply a matter of relation of costs to the results obtained. While there are some compounds on the market which are worthless, and some manufacturers who offer cure alls and do not give satisfactory service, there are other compounds which are reasonably satisfactory and do not involve a large plant investment. Though the weight of evidence is very much against the indiscriminate use of compounds, the fact remains that they are in satisfactory use in many small plants.

Graphite

Graphite has no retarding influence on the formation of scale, but it tends to prevent the scale from adhering firmly to the metal. The particles of graphite simply work through the minute fissures existing in the old scale and gradually penetrate between the scale and the metal. The scale thus loosened may be knocked off or removed with regular cleaning tools with little trouble.

Before starting the use of graphite, the boiler must first be thoroughly turbined. Once removed the scale will not adhere firmly to the metal again as long as the graphite treatment is continued. The graphite also becomes intermixed with new scale as it forms, rendering it soft and friable. With graphite, as with boiler compounds, any boiler using bad water should be blown down a gauge or two every few hours to remove sludge.

Kerosene

Good results in softening scale are sometimes secured through the use of kerosene and other refined petroleum oils. This treatment changes the deposits of lime from a hard scale to a friable material which may be easily removed. If the treatment is to be effective, kerosene should be introduced after the boiler is emptied and washed, and the refilling should be effected from the bottom. If kerosene is fed into the boiler with the feed it may form a non-conducting film over the heating surface.

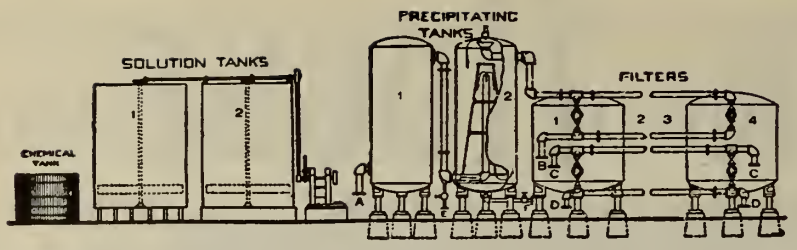
Zinc

While zinc is often introduced into boilers to prevent corrosion and scale formation, it does not as a matter of fact always accomplish this purpose, and it may even aggravate the trouble. The action of zinc is electrolytic, the theory being that a continuous flow of hydrogen is generated over the whole extent of the wet surface of the boiler. It is supposed that the continuous formation of the bubbles of hydrogen insulates the surface of the metal from the scale forming substances. If there is a little of the scale forming element it is precipitated and reduced to mud; if there is considerable, a formed scale is produced which however does not adhere tightly to the surface of the metal and is consequently readily removed.

The zinc is introduced in the boiler where it is suspended in the water in the shape of blocks, slabs or shavings, in a perforated container. In marine practice where zinc is in much greater use than in stationary boilers, it is usual to find zinc slabs 12 inches by 6 inches by 1½ inches in use. One square inch of zinc surface is ordinarily supposed to be sufficient for 50 lbs. of water in the boiler, although as a mater of fact the quantity of zinc used should be in proportion to the hardness of the water. The British Admiralty, who are advocates of zinc, recommend renewing of the slabs when their disintegration reaches a depth of ¼ inch.

Boiler Metal Treatment

A treatment which has in recent years come into quite wide use consists in the application of Peroln. This is a blue viscous non-volatile mineral liquid, which possesses the characteristic of an exceedingly high co-efficient of expansion. The



The Scaife System.

liquid is injected into the boiler in small daily doses. It penetrates the pores and crevices in the scale and comes into direct contact with the metal, where like graphite, it works its way along the steel, eventually forming an insulating coating between the scale and the tubes. The high co-efficient of expansion tends, whenever the boiler is cut in, to loosen any scale which has formed.

Advantages and Disadvantages of Compounds and Metal Treatment

Compounds and metal treatment of the various sorts described above possess the advantage of not requiring an initial investment and of lending themselves very readily to experimentation. In case a given compound or treatment does not work, it may be modified, or another treatment may be tried. The operating costs are also less per gallon of water treated than where special treatment is installed.

The serious disadvantages of compounds and metal treatment are that under favorable conditions all that the most effective of these methods can do is to change the nature of the scale forming material from one which will be precipitated, to one which will be carried in suspension. Frequent blowing off is at all times necessary with consequent heat losses, and as the accumulation of sludge can never be entirely removed while blowing off, so that the boiler is frequently cut in for washing. This puts the boiler out of commission and entails a loss on the investment in the boiler whenever an extra steam generator must be provided to take the place of those cut out for washing. Frequent cutting in and out of the boiler itself is an expensive operation. Taking everything into consideration, compounds and metal treatment are to be recommended for use primarily in small plants. In large plants and in particular where steam must be continuously generated, we must turn to a method of treating the water before it enters the boiler.

Water Softening and Purifying Plants

The treatment of water outside of the boiler through the medium of water softening plants is accomplished by either one or two processes, known as the intermittent and the continuous.

Cold process plants are used primarily where water is required in very large quantities. Hot process plants are commonly used where exhaust steam is available for heating the water.

With the continuous system, the water to be treated flows to the softener in a continuous stream, while with the intermittent system it is treated in batches. Successful treatment in either case requires the proper proportioning of water and chemicals, through miring and agitation, and the allowance of sufficient time for the reaction to take place so that all of the sludge may be removed from the water.

Lime and soda are the principal ingredients used in these processes, where sulphates of lime and magnesia are contained in the water, together with such quantities of carbonic acid or bicarbonate present as to impair the acton of the soda. This is quite a common condition. The sulphates of lime and magnesia are broken down by the soda, and as much lime is added as is required to take up the carbonic acid not absorbed in the soda reaction.

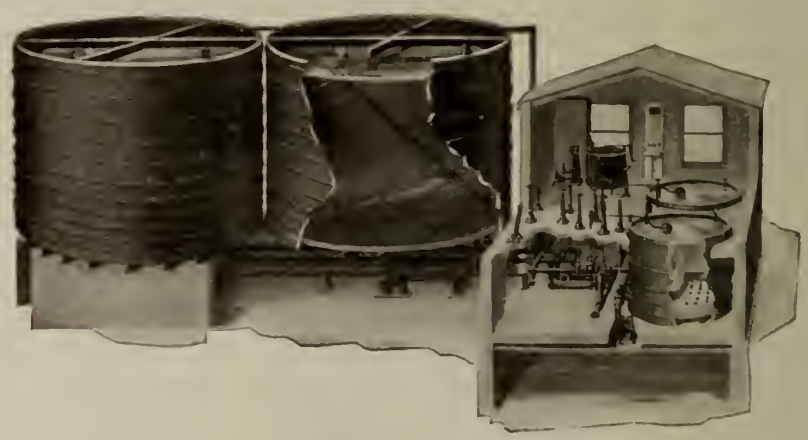
Before dealing with the apparatus, it may be well to describe simply the chemical tests of the treated water which will enable us to interpret intelligently the results being obtained. Alkalinity, hardness, and causticity, should, when the water is properly treated, be in the approximate relation of six, five and four. The use of too much lime will result in causticity being nearly equal to alkalinity. The use of too little lime will result in a causticity amounting to only about half the alkalinity. If too much soda is used, hardness, which should not be more than two points less than alkalinity, will be decreased below this amount, and the alkalinity correspondingly increased. Too little soda means an increase in hardness and a decrease in alkalinity. The tests are as follows:

Alkalinity: Provide a standard solution of sulphuric acid. But sufficient methyl orange in 50 cc. of the water being tested to color it. Measure out a quantity of the acid solution and put it in a drop at a time. As the solution is added the mixture will begin to turn red. Shake the mixture and the redness will tend to disappear. Put in more acid and continue to shake. As the critical point is approached the red will disappear more slowly. When the red color is permanent, the critical point has been reached. 1/10 cc. of the acid solution is equivalent to one degree of alkalinity.

Causticity: Use the same standard solution of sulphuric acid. To 50 cc. of the treated water add one drop of phenolphthalein dissolved in alcohol. This is to give the water a pinkish color. Put in a drop at a time of the acid solution, shaking after each addition. The critical point is reached when the color entirely disappears. 1/10 cc. of acid solution is equivalent to one degree of causticity.

Hadness: Procure a standard soap solution. To 100 cc. of the water to be treated, add 1 cc. of the soap solution, and shake thoroughly. If the soap bubbles disappear, add another cc. of the soap solution. Enough of the soap solution must be added to make a permanent lather or foam from which the soap bubbles will not disappear after the shaking is discontinued.

To determine the excess of lime, add a small amount of silver nitrate to the treated water. If a milky solution is formed the lime is not in excess. If the mixture turns brown there is too much lime.



The We-Fu-Go System.

The Scaife System

In the Scaife system which is a continuous one, the feed water first enters the heater where it is brought to a temperature or 200 to 210 deg. F. As a portion of the CO_2 is driven off by the heat, carbonates of lime and magnesium are precipitated and deposited in removable pans inside the heater.

The system consists of a number of precipitating tanks with one or more pressure filters, all built to operate under boiler pressure, and the necessary solution tanks, pumps and controlling devices. The precipitating tanks may be either horizontal or vertical, depending upon the space available. The solution

tanks hold sufficient quantity of chemicals to operate the plant from eight to twelve hours. The small pumps deliver this solution to the precipitating tanks, which are so constructed that the water is kept moving and the chemicals are intimately and thoroughly mixed. In this manner acids are neutralized and the scale forming substances are changed to insolubles which sink in the form of heavy precipitates to the bottom of the tank, whence they are readily removed. From the precipitating tanks the mixture moves to the filters where the lighter substances in suspension are effectively removed.

We-Fu-Go System

The We-Fu-Go is an intermittent process. The system consists essentially of one or more solution tanks from which the chemicals are taken, and one or more settling tanks into which the water to be treated and the chemicals are introduced, and of one or more filters. A thorough mixture of the chemicals and the water in the settling tanks is effected by the use of mechanically operated paddles located near the bottom of the tank. The softened water is taken out of the tank by means of a hinged floating outlet pipe, arranged to rise and fall with the level of the water, so that the water is always drawn from the top, where there is least amount of sludge. From the settling tanks the water flows by gravity into the filters, which remove all remaining solid matter which has not dropped to the bottom of the settling tank.

From the filter the purified water again flows by gravity into the clear water storage reservoir from which it is pumped to the open heater and thence to the boiler. As a general rule duplicate systems are employed, so that while one tank is being treated and settled, the other is supplying finished water.

It should be understood of course that the above descriptions of the Scaife and We-Fu-Go systems are general in nature, as modifications of both of these systems are often made to meet special conditions.

Our next article will deal with the operation and maintenance of the water softening plants described in this article and we will also take up in detail the design, construction and operation of Zeolite plants.

BRUSH AND COMMUTATOR TROUBLES

Not only should great care be given to brushes when first installed, but they should also receive careful attention throughout their life. Brushes, holders, and commutator should be cleaned thoroughly and regularly, so that it will be certain that each brush shall have free play in its box, and that the pressure arm also shall have free movement. Such attention to detail may mean the difference between good and poor brush operation. Usually when brushes are operating poorly they are shouldered with the entire blame irrespective of conditions. There are conditions, however, under which any brush will operate poorly. One very common fault is copper-picking, and usually this is carried by other reasons than improper brushes. Often this fault, is exceedingly difficult to correct. Occasionally, brushes pick copper immediately after being first installed, while their surfaces are still freshly sandpapered and the commutator surface is raw. Under these circumstances brushes pick up copper that is liberated by mechanical abrasion. If this be the case, the trouble can be overcome by carefully wiping off each brush from time to time until the contact surfaces are polished. However, in most instances copper-picking is caused by circulating currents in the faces of the brushes. Machines with interpoles or pole-face windings are much less liable to copper-picking than the non-interpole machines On the latter type of machine a better brush position for the required load conditions may effect an improvement in this fault. Often poorly sanded brushes, with resultant small areas of contact, cause undue circulating currents to flow, resulting in extreme local heating, which in turn burns off the particles of copper from the commutator bars, and these particles are caught by the brush surfaces. Sometimes, under certain conditions brushes of only one polarity are affected—usually the positive brushes on a generator or negative brushes on a motor; that is, copper is carried along with current flow from copper to carbon. After all other efforts fail an improvement may be made by changing the grade of the brushes, this change having the effect of altering the amount of circulating current or acting as a damper to the passing of copper particles from commutator to brush.

Ridging or grooving of commutators is another fault that is distressing to the operator who takes pride in keeping his machines in the best condition. The location of the brushes on the commutator plays a great part in correcting this fault. The method of staggering brushes around the commutator which gives the best results is to have the staggering done in pairs of studs rather than alternately. The latter method permits the positive brushes to track on one part of the commutator, while the negative track on another. It is found that usually the negative brushes on a motor wear the commutator much more rapidly than the positive; hence, if all negative brushes are permited to track each other, grooves will form, leaving ridges under the positive brushes. Excessive grooving may be caused by a too-abrasive brush, by too much spring tension, which should be only great enough to keep intimate contact between brush and commutator, or by improper brush position or commutating-pole adjustment permitting undue circulating currents to be present in the face of the brush, causing excessive local heating, which burns away the copper.

Frequently operators apply lubricant to the commutator in an endeavour to stop the grooving action. This practice is not advisable, as the lubricant is liable to gum on the commutator, causing varying contact drop and position of the brush. For the same reasons the use of impregnated brushes is not recommended.

Chattering of brushes is another distressing fault, which is caused by using an improper grade of brush, by brushes operating at the wrong angle, by the commutator surface being uneven or out of "true," or by high mica. Trailing brushes work best at 15 degrees or less, while leading brushes, reaction type, should have an angle between 30 degrees and 40 degrees. (The angles as here used are the degrees of tilt from the radial position.) It will not be necessary to elaborate on uneven or out-of-true commutator surfaces, as all are familiar with this phase of trouble. However, high mica may be the cause of trouble when least expected. Even after a commutator is newly turned down, the mica may be slightly high because the machinist has not had the proper edge on the turning tool, and consequently the copper has been cut away more than the mica. A good stoning or strenuous attack with carborundum cloth when the machine is cold will be necessary to take down the mica. Chattering is often present on a commutator having surface speed too high for the particular grade of brush used, hence it is urged that operators keep within the limits of speed as outlined by the brush manufacturers.—"Electrical World."

WATERPOWER DEVELOPMENT IN JAPAN

"Japan is pushing work on hydro-electric development as the demand for power in the larger cities as well as smaller villages is far in excess of the supply available," according to Stephen Q. Hayes, a special electrical engineer of the Westinghouse Electric & Manufacturing Company, who just returned from a six months' tour of Australia and Japan, where he made a special study of business conditions. Tokyo and Yokohama, near the eastern end of the main island, are supplied with power at fifty cycles from many hydro-electric plants and there is an electrified section of the railway between these two cities with multiple unit trains every ten or fifteen minutes.

Near the middle of the main island, about 350 miles from Yokohama and Tokyo, are the large manufacturing cities of Kyoto, Osaka and Kobe. These are fed by numerous transmission systems operating at sixty cycles. Some of the most important hydro-electric generating stations are located about half way between the two groups of cities and some interesting problems are involved in making some of these stations suitable for feeding fifty cycle current to Tokyo and Yokohama and sixty cycle current to Kyoto, Osaka and Kobe.

Continued on page 25

What Pulled The Head In? Is This A Collapse?

An Accident Occurs, and the Question of What Can be Called a Collapse is Brought Up—Can a Place Collapse When the Pressure Tends to Blow It Out

BOILER insurance companies sometimes have claims to settle which are more or less controversial, by which we mean that the damage is not of a nature that leaves no room for doubt, as to the liability. A case of this kind has been brought to our notice recently, and we feel that it gives an opportunity for some readers to do a little thinking and to put their opinions on record. The case is as follows:—

A boiler of the horizontal return tube type, insured against explosion, rupture or collapse, which is the general way in which these policies are written, sustained a severe bulge in the furnace sheet. The boiler had been standing under banked fires during the night, and the bulge occurred while the fires were being brightened up in the morning ready for the factory to start. The engineer was informed on his arrival at the plant that the gauge glass was full, but instead of that, he found the boiler was without water, and the plate over the fire bulged for one third of the circumference and for about six feet in length. The fires were drawn and the boiler pressure released, and when the boiler was sufficiently cooled down an examination was made. The plate over the fire was then discovered to be bulged for one third of its circumference, and about six feet in length, while the front end plate had been drawn in at the bottom, to the extent of about 1⅛ inches. The owners of the boiler claimed that this drawing in of the front end plate was a collapse within the meaning of the policy. The whole of the case then as regards the front end plate hinged on the cause of this drawing in. Could this deformation or bending in of the tube plate be considered a collapse? A collapse is understood to mean a crushing of the plate due to the surrounding boiler pressure, as in the case of a circular furnace tube or a fire tube in a H.R.T. boiler. It can be clearly understood from the construction of a H.R.T. boiler that no external pressure could so bulge inwards the front tube plate. For the tube to bend in this manner it must do so against the internal boiler pressure, which tends to keep the plate in shape, or otherwise bend it outwards.

The lower part of the front end plate was rigidly supported by the tubes and also by the two direct stays underneath the tubes, and this support was entirely independent of the support given by the attachment of the end plate to the first circumferential sheet. The lower tubes were actually protruding through the plate from ½ inch to 1 inch after the deformation took place.

Presuming that the end plate had no support such as tubes and stays, it would have a resistance to bending due to its sectional area, and in order to remain in equilibrium this amount of resistance would have to be equal to the bending moment exerted upon it. Owing to the presence of the stays and tubes however, the resistance to bending would be very much greater than if the plate was unsupported. We must however, remember that the temperature of the end plate would be much higher than normal, and on this account the support accorded by the tubes and stays can be assumed to be reduced about 50%, which is perhaps a liberal allowance. We have then the fact that we have a plate or if we consider a small portion of the head, a strip or bar supported at the ends, or fixed at the ends and uniformly loaded by the pressure in the boiler. The tendency then would undoubtedly be to force the plate outwards. However, the plate undoubtedly bulged inwards. We must then consider if it was possible for the furnace plate in bulging to exert a force sufficient to draw the head in against the supporting pressure of the steam in the boiler and the tubes. The resistance of the metal is of course lessened by the temperature, and we have no means of knowing what the temperature amounted to. The force exerted on the furnace plate by the boiler pressure was expended in deforming the metal, and here again we are not sufficiently supplied with data. If the metal was bulged outwards without any contraction of area, as occurs in a testing machine then some other part of the boiler would have been deformed to allow for the deformation of the furnace plate. If however, the bulged portion suffered a contraction of area, there need be no deformation of any part except that locally affected.

On the other hand, could there have been a force exerted when the metal was cooling and contracting to cause the deformation of the end plate? This again would depend on how far the overheating extended and to what extent. If the bulge in the furnace plate had occurred without any contraction of area, and the overheating extended in gradually diminishing temperature from the centre of the bulge to the end plate, it is natural to assume that the less heated parts would cool first, and in cooling draw in the heated part, that is the deeper part of the bulge and this is more readily assumed because the pressure in the boiler would be exerting less force, due to a lowering of pressure. There would then be no tendency to draw in the head.

View of boiler showing bulges.—Tubes and stays removed.

Supposing that when the boiler was in normal working order, the direct stays were in a state of tension, not only due to the pressure in the boiler, but a certain initial tension placed upon them when setting them up in the first place. Now suppose when the heating took place, this extended to the front end plate in some degree so as to lessen its power of resistance. The bulging takes place in the furnace plate, and the stays not being in compression have no tendency to resist the drawing in of the head to conform to the altered shape of the boiler. The

heating of the end plate has we assume, lessened the resistance due to the tubes. The bulging of the plate, coupl-with the pulll of the stays in tension, may have been sufficient to overcome the pressure of the steam on the small area which bent inwards. Can this be assumed to be a collapse? This is an interesting question. The dimensions of the boiler were 66 inches diameter, by 16 feet long. The shell plates were 7-16ths, while the head was ½ inch tubes. The bulging of the plate, coupled was 4 inches deep at its extreme point, while the indent in the head was 1 1-8th inches at its extreme depth. The pressure in the boiler was 125lb. per square inch. The stays in the boiler under the tubes were 1¾ inches in diameter, while the tubes were 3 inches diameter.

This case has been settled, but it is quite possible that other cases of a like nature may occur, and it is therefore of interest to see what arguments can be brought forward by engineers to confirm or oppose the claim of collapse. Suppose such a thing should happen to a boiler that you had charge of, and it was up to you to formulate the claim to the insurance company. How would you meet the claims of the company's engineers, or how would you substantiate your own claims?

WELL KNOWN ENGINEER DIES

Angus Sinclair, who was well known as a civil engineer and railway contractor, died a few days ago in Toronto. Mr Sinclair built many of the railway lines on the Canadian Pacific and Canadian Northern systems, and was well known in Chatham, N. B., where he was born in 1849. Since that time he passed through many experiences. In 1869 he joined the staff of the Intercolonial Railway and remained until 1875, when he supervised the completion of the road from Matapedia to Bathurst. He came to Ontario in 1875, joined the staff of the C. P. R. at Port Arthur under the late Samuel Hazelwood in 1875 and remained in that district until 1878, when he abandoned engineering for contracting, and continued on the C. P. R. as a contractor until the road was completed.

He built a section of the C. P. R. east of Toronto, and in partnership with William Doheny constructed the road from Thamesville to Windsor for the C. P. R. Later. in partnership with the late Allen R. I. McDonnell, he constructed 50 miles of C. P. R. short line through Maine, built a portion of Walkerville railway and a section of the Maine Central Cystem, from north Stratford to Hazen Junction in Vermont. He was continuously employed on the C. N. R. System since 1898, during which time he has built from Point Tupper to Broad Cove, B. C., from Halifax to Mahone Bay and Middleton to Victoria Beach, N. S. He returned to Ontario in 1903, and has since built or completed from Toronto to Ruel and from Capreol Junction to Pembroke, 240 miles. He was also engaged in completing the excavation of the open work of Mount Royal Tunnel through the City of Montreal.

OTTAWA LODGE NO 6 C.A.S.E.

An open meeting of the above lodge was held on Aug., 25th in the Trade and Commerce Hall, Wellington St. The meeting was very largely attended and the audience heard a very entertaining from Mr. C. I. Grierson, lecturer and demonstrator of the Imperial Oil Co. Toronto, illustrated by moving pictures. The lecture was given by the courtesy of Major A. E. Oliver, manager of the Imperial Oil Co. The lecture explained and illustrated the winning of petroleum from the earth, and its subsequent distillation and separation into the various lighter volatile liquids, and lubricating oils. The handling of the finished product and shipping into tank cars and tank steamers was illustrated. Probably the most interesting part of the lecture to the engineer was that dealing with ture to the enginer was that dealing with the various oils used for lubricating bearings, their use and abuse. Mr. Greirson who handled his subject with great clarity, had a lot of questions to answer on this part of the lecture.

Ottawa Lodge has been giving a series of open metings which have attracted a lot of attention. Since the convention the Lodge has added no less than fifteen new members to their number, and have great hopes of doubling their membership in the next few months. The president is Mr. J. J. Sullivan, and the recording secretary Mr. R. E. Rodney, 15 Lorne Avenue Ottawa.

TORONTO LODGE NO. 1 C. A. S. E.

Mr. S. G. Hall, president of the Toronto No. 1 C. A. S. E., has recently left town to take up a position in Newmarket, which prevented him from giving the attention he deemed necessary to the first position in the lodge. Mr. Hall therefore resigned the office, and at a recent meeting Mr. Truelove was unanimously elected as President.

EXHIBITION NOTES

The Dominion Belting Co.

are showing a complete line of conveyor and transmission belting. This is the well-known Maple leaf cotton stitch belting. Belt fasteners, belt dressing and other supplies are also displayed. E. Kinrade is in charge.

WATER POWER DEVELOPMENT IN JAPAN

Continued from page 23

As the demand for light and power in the large cities is so greatly in excess of the available supply, rates are high and the distributing companies have not encouraged the use of electric heating appliances and household utensils. When the contemplated extensions to the power companies systems are completed in the next few years, there will probably be a wonderful market for electric cooking and heating appliances and labor saving devices.

The English Electric Co., Limited of Great Britain, the largest manufacturer of electrical equipment and machinery in the British Empire is associated with the English Electric Company of Canada, Limited. The Canadian Company is associated with and holds the exclusive manufacturing rights in perpetuity for the English Company; having use of all their patents, designs, processes, etc.

The entire undertaking of the Canadian Crocker-Wheeler Company, Ltd, of St. Catharines has been acquired so that all the valuable patents and designs of this Company are available.

PERSONAL

E. D. Kilburn, Vice-President and General Manager of the Westinghouse Electric International Company has left New York for a trip to Mexico. While there Mr. Kilburn will make a survey of general business conditions looking forward to considerable expansion in the electrical industry in that country.

Owing to the growth of business in China, the Westinghouse Electric International Company has opened on office in Shanghai. This office will have eventually several branches throughout the country in order to adequately handle inquiries and negotiations for electrical equipment. J. D. Birrell, who has long been engaged in business in the Far East, is the manager of the new office.

MAKING WOOD FIREPROOF

Some recent technical notes from the Forest Products Laboratory state that progress has been made in the preparation of fire retarding paints as the most practical means of making small amounts of wood somewhat fire resistant. Older methods of impregnating the wood with chemicals under pressure or means of keeping it moist are usually too expensive for small projects although they are more effective. Ordinary white wash or calsomine has proved to be as satisfactory as any other type of paint. A coat of calsomine will not prevent the burning of the wood if exposed continuously to great heat but it does materially decrease the danger of a blaze spreading from sparks, cigarettes, and other small sources of fire. Calsomine is naturally best suited to inside uses. For outside work the Laboratory has developed a coat which consists of zinc borate and chrome green ground in linseed oil. This paint after three years of exposure to the weather has retained its fire resisting properties.

The Application of Oil Fuel to Steam Boilers

The Following Notes Are the Result of the Experience Gained by Members of the Manchester Steam Users Association During the Recent Coal Strike in England—These Will be Found Interesting to Canadian Readers

DURING the recent coal stoppage we made observation of a number of typical oil firing installations and it may be of service or interest to our members to record briefly our impressions.

The types of apparatus in use may be divided into two classes which differ widely in their various features, viz.:

(a) The Pressure Jet System.

(b) The Steam or Air Jet System.

Class (a). The oil is atomised by pumping it under pressure through specially formed burners from which it issues with a whirling motion at high velocity.

The atomising is generally better than in the steam or air jet system, and combustion may be almost perfect in this type, but the installation, involving a pumping set and special furnace fronts, etc., is, of course, considerably more costly than Class (b) apparatus.

Class (b) includes those burners in which the oil is "atomised" by steam. This class is important by reason of its extensive adoption as a more or less temporary measure to assist members to keep their works going with little or no coal, and its advantage is its comparative cheapness. Many simple oil sprayers are in use, with a small oil tank on the boiler top and perhaps a larger storage tank in a safe place conveniently near to the boiler, fitted rapidly and at trifling cost. They are quite effective and have assisted many of our members to keep going, but there is no doubt these "burners" are very wasteful, the oil being sprayed rather than atomised, with the result that globules of oil of appreciable size are thrown off. These globules are too large to be burned at once, and since the temperature of the flame falls rapidly there is no chance of complete combustion beyond the region of the flame and a large percentage of the oil is wasted. In one case we noted, a cross tube Vertical Boiler the weight of first class fuel oil being used was at least as great as that of the very poor coal previously used for the same duty. A little brickwork in the firebox greatly improved the result, however.

For use of compressed air as atomising agent the burners are similar to those used for steam atomising, but compressed air has not been extensively used for steam boilers, being more suitable for certain process furnaces (metallurgical furnaces, etc.). An objection to air atomisation for boilers is that the provision of a compressed air supply is less convenient and more costly generally than steam, whilst the system is less efficient than Class (a),

There are, however, several high-class burners on the market for the use of steam as the "atomising" agent, which have been put forward as permanent apparatus and we have seen practically perfect flames from steam burners (about 5 ft. to 6 ft. long and say 1½ ft. diameter in a circular furnace, yellowish white generally, and inclined to a reddish color at the tip). Most of them that we have seen, however, have a strong tendency to the "sparking" or blowing through of globules of unburnt oil referred to. This tendency is more marked when using heavy oils and is reduced where the oil is well warmed and the atomising steam superheated sufficiently to prevent condensation at the burner. It is to be noted that in the burning of oil more water is formed in the flue gases than with coal, and steam for atomising will still further increase it, raising the dew point in the flue gases. It therefore becomes necessary to see that the water entering the fuel economiser, where such is fitted, is kept at the proper temperature to prevent "dewing" on the economiser piper and consequent wasting of the latter. About 120° F. will usually be found sufficient.

The best of these steam atomising burners give very good evaporation results, but cannot compare favorably in oil consumption with the Pressure Jet type.

In most makeshift oil burning arrangements the firebars are not removed and are usually covered with burning coal or with firebrick. It is almost impossible for coal to burn well under these conditions for it is impossible to supply the necessary excess air over the bars. Probably the better plan is to burn the coal in one furnace and the oil in another. Firegrates covered with brick are also a disadvantage for they reduce the volume of the combustion space and force the flame against the furnace plate where its combustion is killed. For burning oil alone it is much better to remove the firebars, the size of the available furnace or combustion space being an important factor. Flames which strike the heating surfaces are cooled rapidly and their combustion is incomplete. Much excess air has then to be introduced and much heat is carried up the chimney. Brick combustion chambers of watertube boilers offer a great advantage from a calorific point of view. Thus in a recent trial with a Stirling boiler the waste gas temperature dropped from about 600° F. with coal to about 450° F. with oil. This was due to the more perfect combustion and as it was necessarily accompanied by a reduced air supply a double gain was effected. It was, of course, accompanied by a high flame temperature which was so intense that after four days working about 14 inches of fire brick had been destroyed.

Fuel Oils

Speaking generally, the steam or air atomisers are more successful with the lighter fuel oils than with heavy oils and the "pressure" systems deal successfully with either light or heavy oils. We find that it is difficult to avoid drip from the steam or air burners using the heavier oils, and at the same time good atomisation is difficult, and commonly, a steam burner which will successfully deal with light oil will be very unsatisfactory with heavy oil at a safe temperature. In warming the oil for use in open tanks, etc., care must be taken to keep below the flash point of the particular oil used, which should be ascertained from the oil vendors or by test. If heated too highly valuable fuel is wasted and there is danger of fire. We find about 130°—140° F. generally suitable for the ordinary gravitation apparatus, with steam or air atomisation, but much higher temperatures (200° F. and over) are usual when dealing with heavy oils in the Pressure systems in which the principal heating is done under pressure.

It is necessary to clean out the oil supply system occasionally and commonly the pumping units are supplied in duplicate for convenience in doing this. It is sometimes inconvenient to stop for "steaming out" when there is no duplicate apparatus, and in that case the system can be kept clear by using light oil for a short time. The heater temperature need not be so high as for heavy oil, 130° F. or thereabouts being generally suitable.

Much alarm has been expressed about a possible injurious effect of the blow pipe action of an oil flame. Experience is as yet limited but no case has presented itself of serious trouble due to this cause and it is doubtful whether a long oil flame in a cylindrical furnace has so high a temperature as sometimes exists in a forced-draught coal fire just above the line of firebars. In fact, long oil flames are, as a rule, due to imperfect atomising, a jet of oil being carried straight to its destination with only a poor chance of perfect combustion. Such a flame would be relatively cool and could do no harm unless, of course, the furnace is covered with scale or grease.

Flue Gas Explosions

Flue gas explosions are more common with oil fuel than with coal, es-

pecially with the steam or air-jet type, and a few words on the subject may be useful.

A mixture of atomised oil and air is explosive and it is important that the oil should be burned as soon as sprayed or atomised. In the event of a flame failing and the oil continuing to flow unburnt there would soon be a considerable volume of explosive gas in the flue, which would explode on reaching ignition temperature. We would suggest that two burners in one furnace are preferable to one larger one—the likelihood of both failing together is much less than that of a single one failing. Further, the range of boiler duty is greater and a better average mixture of oil and air can be maintained in a furnace having a number of burners than where there is only one. There are other causes of flue gas explosions, for instance, unburnt oil in the flues where it will vaporise, perhaps while the boiler is at rest during the night, to explode when the boiler re-starts work.

To avoid these risks, the flame should be kept under constant observation, and the flue dampers opened wide before lighting up for sufficiently long to ensure that the flues will be clear of gas. Should it be found that a flame has failed and oil vapor is passing unburnt into the flues, the oil should be shut off until the flues are clear, before relighting. Any oil leakage is of course objectionable and may be dangerous; in one case oil found its way into the boiler side flue from a leaky tank, resulting in a gas explosion which caused serious damage.

In boilers with high flues and the openings at the bottom (as Stirling type, etc.), we think it desirable to provide for the ventilation of the upper parts, as for instance by a small pipe to the chimney.

The sudden cooling of boilers or brickwork should be avoided; and we would mention in particular that Silica firebrick, which resists high temperatures, is apt to crack if cooled suddenly. Hence when shutting down a boiler having silica brickwork it is necessary to keep the air-admission openings closed and allow the firebrick work to cool gradually.

Regulation of boiler duty should be effected by adjusting the flow of oil and the air admission. For good results there should be a light grey smoke at the chimney top. Complete absence of smoke usually means inefficiency through too much air whilst dense black or yellow smoke means too little air or bad atomising of the oil.

It is convenient to regulate the air admission at the furnaces and in many oil plants, including all the Pressure Jet Systems, this is specially provided for. Flue dampers must not be closed whilst the boiler is working or firemen may be burned by "backfiring"—these dampers may be removed altogether.

Fuel Values Compared

In considering the question of adopting oil as a permanency instead of coal the following questions should be examined:

Calorific value and price of coal available compared with calorific value and price of oil available.

Cost of installation of oil plant, including storage tanks, etc.

Saving in labor and/or machinery for coal and ash handling.

Value of freedom from coal and ash dust in the particular works under consideration.

The fluctuations in boiler performance due to varying conditions of the (coal) fire and to necessary opening of firedoors periodically for charging and cleaning the fires are considerations which weigh in favor of oil firing.

At present of course prices of coal are unstable and considerable fluctuations may be expected. The price of oil also may vary considerably, to say nothing of supplies, and before deciding to change to oil permanently, where fuel costs are of first-class importance, it will be well to await the settling of prices, etc.

If members will let us know the average percentage of ash in their coal, and pare the same with fuel oil as rgards heating value and price. Appended is a comparison of values (approximate) of several kinds of coal, etc., with oil fuel of given calorific value and price.

Taking as a standard, oil £5 per ton.
Waste gases from boiler 660° F.
From economiser 460° F.
Temperature of atmosphere 60°.
Radiation 15 per cent. with ordinary coal, say 2000 B.Th.U. per pound.

	B.Th.U.	%	Price
Boiler	14380	78	100s.
Boiler and economiser	15090	82	100s.

Oil of 18500 B.Th.U. Assume perfect combustion.
Waste gases 15 times weight of oil.

	B.Th.U.	%	Price
Oil of 18500 B.Th.U. Inefficiently burnt.			
Boiler	11500	62	80s.
Boiler and economiser	12100	65	80s.

Subtract cost of steam jets or oil pumps and add saving in labor.
Coal. Nixon's navigation of 15000 B.Th.U.
Waste gases weight 20 time carbon weight.
Ash and moisture 4 per cent.

	B.Th.U.	%	Price
Boiler	10250	68	70s.
Boiler and economiser	11160	74	75s.

Subtract cost of handling ashes.
Coke of 10000 B.Th.U.
Waste gases weight 20 times carbon weight.
Ash and moisture 30 per cent.

	B.Th.U.	%	Price
Boiler	6020	60	42s.
Boiler and economiser	6680	67	44s.

Subtract cost of steam jets and of handling 20 per cent. ashes.
Ordinary coal of 13500 B.Th.U. Hand fired.
Waste gases weigh 25 times carbon weight.

	B.Th.U.	%	Price
Boiler	8140	60	57s.
Boiler and economiser	9260	69	61s.

Subtract removal of 5 per cent. ashes.
Inferior coal of 10000 B.Th.U. Hand fired.
Waste gases weight 25 times carbon weight.

	B.Th.U.	%	Price
Boiler	5180	51	36s.
Boiler and economiser	6120	61	40s.

Subtract removal of 20 per cent. ashes.
Add or subtract from estimated "inferior" coal values as follows per 1000 B.Th.U.

	B.Th.U.	%	Price
Approximately	880	2.0	6s. 3d.
	930	2.5	11s. 6d.

A few words of explanation will be useful as indicating how the figures are arrived at.

Column 1, headed "B.Th.U." gives the heat units actually utilized by the boiler, and by boiler and economiser, under the stated conditions, representing Calorific values, minus radiation, minum heat in waste gases.

Column 2, headed "Per cent." gives the Thermal efficiency.

Column 3, headed "Price," gives the value of the fuel compared with oil at 100s.

Taking coke of 10000 B.Th.U. for example, we have, per pound:

Carbon (or combustible) weight 0.7 lbs.
Waste gases 0.7×20 14 lbs.
Heat lost per 1° F. excess temperature of waste gases above ordinary temperature $=14 \times 0.236$ B.Th.U. (.236 is specific heat of the waste gases.)
for 600° (boiler alone) .. 1980 B.Th.U.
400° (Boiler and economiser) . . . . . 1320 B.Th.U.
Heat lost by radiation 2000 B.Th.U.
Heat utilized by boiler $=10000-2000-1980=6020$ B.Th.U.
Heat utilized by boiler and economiser $10000-2000-1320-6680$ B.Th.U.
Value of fuel compared with oil at 100s. $= 6020 \times 100$s. $=42$s.

(Boiler alone) 14370
Value of fuel compared with oil at 100s. $= 6680 \times 100$s. $=44$s.

(Boiler & economiser) 15090

When the cost of steam jets and of handling ashes, etc., is taken into account the value of the (solid) fuel is naturally less than these figures as compared with oil.

Some Principles of Oil Burning

In view of the permanency of a number of oil-firing installations, it has been desirable to add a few words on the leading principles of oil combustion. The Wells burner and similar ones produce a gas flame by forcing oil through a coil of pipe exposed to the temperature of the flame, and the resulting oil vapor emerging out of a suitable burner induces a draft of air in which it burns. This burner does not seem to have been used for boiler firing, possibly because the available oil fuel is thick and would therefore "crack" if exposed to a high temperature and the resulting carbonaceous residue would doubtless soon choke the pipes.

In a close approach to this type of burner, the oil is heated by steam to near its boiling point. If, in addition, superheated steam be used for atomising the oil, it is probably gasified as it leaves the burner. In other cases the globules of oil are so infinitesimally small that when mixed with air they practically constitute an explosive mixture which ignites when heated.

The smallness of the oil globules is an important matter as will be seen from the following consideration. Even "large" globules are of small dimensions, say at most 1/1000 inch diameter. They, therefore, travel with the air in which they burn. They do not move across their surrounding air and therefore do not shed their mantles of products of combustion. These consist of an outer shell of carbonic acid gas with an excess of air, inside of this one is a shell of CO_2 and nitrogen but no oxygen, inside of this one there will be a shell of carbon monoxide and perhaps oil vapor, which shell surrounds a kernel of cracked oil, a carbonaceous spongy mass which is difficult to ignite. Some sort of mixing will take place in the body of the flame, but as the oxygen percentage is now much reduced, re-ignition and further combustion will not take place unless the flame is very hot. Now the larger the oil globules the more imperfect will be what might be called the first combustion and the more imperfect will be the secondary combustion when the carbonized kernel, the combustible gases and vapors, have gradually freed themselves from their surrounding incombustible mantles. The result will be much smoke due to the minute kernels of cracked oil residues. To counteract this nuisance an excess of air has to be admitted with the oil spray which means of course serious inefficiency. Another remedy against incomplete combustion is to fit a perforated brick screen in the midst of the flame. It will create a turmoil and thus bring the unconsumed gases and vapors into contact with the remaining oxygen during, and not after the first combustion, and as this turmoil takes place in the proximity of whitehot brickwork combustion is likely to be complete, provided the oil globules were not too large at the start. Such screens have to be made of the best firebrick otherwise they will melt.

The object of atomisers is therefore to produce oil globules of the very smallest dimensions. Now whatever the type of burner, the oil necessarily is in contact with a hard surface, and gliding along it acquires a rolling motion before it is liberated. This rolling motion is probably the chief atomising factor, for the bursting pressure due to centrifugal force increases with the square tension of the oil, which is very powerful in small globules. The surface tension diminishes with increasing temperature and disappears at the boiling point, therefore warmed oils atomise more easily than cold ones. A good burner should produce a high rotary motion in the oil globules. Many oil burners are merely ejectors and impart very little rotary movement to the oil. The worst type would be a spray of oil impinging on wire netting, for here two particles of oil, after rapidly sliding round a wire and acquiring some rotary motion, meet before being blown off and naturally destroy their opposing rotary movements. Obstructions of any sort in front of a burner are bad. It is also probable that large creeping surfaces for the oil are bad because the long continued friction must reduce the velocity. Rounded edges of nozzles are likely to produce very large drops. Possibly knife edges might improve matters. Apparently the burners which give the best results are the mechanical atomisers in which pressure is applied to the oil which emerges from minute orifices at a very high velocity. In steam and air atomisers as the names imply, the oil is not under pressure, but steam or compressed air impart their velocity to it. Much depends on the design. In the best atomizers thin films of oil acquire a rotary velocity which may be half as high of that of the steam or air, in others the steam or air merely propels the oil without breaking it up. In many atomisers the contact of the oil with the steam or air is at the point of greatest pressure. This seems to be a wrong principle; the steam ought to be allowed to acquire a maximum velocity as in the de Laval nozzles, before it strikes the oil film. Another principle which is more applicable to light than to heavy oils is to allow time for the oil to become thoroughly mixed with the steam (preferably superheated); the oil would by this process be vaporised, not atomised.

EXHIBITION NOTES

The Dominion Steel Products Co., Brantford

have an interesting exhibit. They have a 75 K.W. 375 r.p.m. high compression oil engine in actual operation, and this is said to be the first Diesel engine completely designed and built in Canada. Mr. W. W. Brown, the designer, gave Canadian Machinery a complete description of the engine and while one cannot go into a full talk on the matter in this small space, we can say that the exhibit is well worth a visit. Each cylinder is identical in assembly, and interchangeability is an accomplished fact. The writer saw the arrangements made and if desired one can disassemble any unit without disturbing its neighbor. Even the governor and other smaller parts are arranged on the same principle. The engine is very compact and is completely self-contained. They are said to be fully efficient under both steady and variable loads, this being of considerable importance to any heavy duty engine. The electric generator is, as stated before, part of the complete outfit, and the crane can pick up the complete self-contained unit and place it into position wherever desired. Full details are given in the literature, which is given to those interested.

In addition to the engine, the concern are showing a complete line of cast iron and steel chucks of the design which has already been explained in our columns. These chucks are very neat and their strength is already well known. A varied line of Darling valves is also shown, this company being exclusive Canadian agents for this line. The valves vary in size from 4 in. to 24 in., and hydrants of the Darling type are also shown. In fact a section of one hydrant is supplied. The exhibit is rounded out by the showing of a motor driven two stage auxiliary air compressor. All these various items have to be seen to be appreciated, and either Mr. Brown or the other gentleman in charge will be glad to explain matters in more detail.

* * *

The Canadian Ice Machine Co.

have an excellent exhibit of refrigerating machinery, supplies, and materials. They show a double pipe ammonia condenser; a centrifugal motor driven brine pump; a York double cylinder ice machine; an oil trap, bent coils; a sheet of pure compressed cork, and other supplies in this line. Mr. Haine and P. G. Hender will be at this booth.

* * *

Jones & Moore Electric Co., Ltd., Toronto

are showing a varied line of motors ranging from 1-6 h.p. to 25 h.p. A shoe repair shop outfit in operation is also shown.

* * *

The Lancashire Dynamo and Motor Co., Toronto

are showing a complete line of motors from 1 to 25 h.p. A slow speed motor for commercial sewing machines is shown, and all motors are equipped with ball bearings. A feature of these motors is that they only require greasing twice a year. Motor starters are shown, also a disassembled motor which gives visitors a chance to see the interior parts. Various photographs of installations are included in this exhibit. Mr. Powell, Mr. Steele and Mr. Adams are in attendance.

* * *

Messrs Peacock Bros., Ltd.

have a very varied line this year including Weir boiler feed pumps, Foxboro instruments, Aldrich Vertical triplex pump, Hopkinson valves, Richardson automatic scales, a line of instruments made by the Precision instrument Co., and an interesting display of steam traps, radiator traps, and temperature regulators made by the Darco Co., Inc. They also show the Merco Nordstrom non-sticking plug valve which is something new to this section of the country, a simplex valve reseating machine, a line of safety lamps, a miner's air pick, and other varied lines. This is a very complete exhibit, and Mr. Kudera will be pleased to answer any question put to him.

The Canadian Link Belt Co., Toronto

This company is showing a rather interesting installation, which they call "A Silent Chain paradox." A disk with nine slots revolves in front of a chain drive arrangement, and to the casual spectator certain of the chains do not appear to be moving although they are actually travelling at the rate of over 1000 ft. per min. The secret is that the sprockets used to drive these chains are all certain multiples of nine.

In addition to this drive, racks are shown which contain different kinds of malleable iron and steel chains, buckets, etc. There is also a rack containing their silent and roller chains, also photographs depicting the chains being made at their Toronto plant, also others showing actual applications of such chains. J. S. Stewart, E. C. Burton, R. C. Turner, and F. C. Conant are in attendance.

* * *

E. Pullman Wipers and Waste Co., Toronto

are showing a full line of wiper cloths, knenser kloths, and mop cloths. The latter are featured because they come to the customer in large pieces allowing them to be cut up as desired. They are also very soft and absorbent, two essential features in cloths of this nature. Competent officials are in charge ready to explain the uses of the various kinds of cloths.

* * *

The Dunlop Rubber Co., Toronto

show an interesting exhibit of rubber belting, fire hose, etc. An installation of a Gibraltar conveyor under power is shown, this consisting of a large rubber belt to which cast iron buckets are fastened. Fire hose, garden and industrial hose are also part of the exhibit.

* * *

The Black Donald Graphite Co., Calabogie, Ont.

are showing a complete assortment of their line of graphite products.

* * *

The W. R. Sexton Boiler Setting Co., Toronto

are showing their line of Elkco fire brick, this including special as well as standard shapes. They also are exhibiting their nonpareil dumping grate bars, together with a few boiler settings.

* * *

The Geo. W. Cole Co., Toronto

are showing a very complete exhibit of their various lines, these including a miniature installation, boiler feeders, condensor traps, return traps, receivers, swing check valves, pressure reducing valve, etc. They also show a Kitt's pot trap, and a Kitt's pressure reducing valve. The exhibit is well arranged and G. E. Cole and J. E. Farrell will be in attendance.

HOW TO GET RID OF RUST ON IRON OR STEEL BEFORE ELECTRO-PLATING

By RALPH H. BUTZ

In the electroplating of iron and steel it is always necessary to clean the surface from grease, oil, rust and other foreign matter previous to plating, otherwise, of course, the deposit will not adhere to it. The cleaning of the surface leaves a chemically clean surface and one which is in the ideal condition for rusting. It is not uncommon to find a plater who will carefully clean rust from an iron or steel surface for the purpose of plating it, and then, before the actual plating operation takes place, unknowingly allow it to rust again.

After pickling or cleaning off the grease or other foreign matter, the plating operation will be satisfactory if the article is carried, after being rinsed, directly to the plating tank, as it then will not have an opportunity to rust; but if it is allowed to remain some time, as it is usually required to do, before plating, then trouble usually commences.

Iron or steel which has been cleaned and is ready for plating should never be allowed to dry, if possible. If it is allowed to dry, then it will invariably rust. As it is always impossible, however, to plate the articles immediately after cleaning, and they must remain for some time previous to this operation, then some process is necessary to prevent rusting during such interval.

Clean surfaces of iron or steel may be prevented from rusting by immersion in an alkaline solution of some nature. It does not matter just what this alkaline solution is, but it must be strongly alkaline. Among the substances that can be employed are: Sodium carbonate, sodium bicarbonate, potassium carbonate, caustic potash, caustic soda or lime. These substances, of course, should be dissolved in water. The one which is most satisfactory is sodium carbonate (carbonate of soda or salsoda). This is cheap and readily dissolves in water. Lime water can be used but is not as good as sodium carbonate for the reason that it is apt to leave a film of carbonate of lime on the work, and this must afterwards be removed with weak acid. The sodium carbonate is the best substance for the purpose.

Editor's note:—At present there are several preparations on the market that claim not only to cleanse the parts, but protect them from rust. Recently we were privileged to watch a demonstration of such a compound, and the parts dipped were not only allowed to dry, but were left for some considerable time without any sign of rust. Rust can be likened to one rotten apple in a barrel of good apples. Once let it get a start and it will go through the whole barrel

The D. K. McLaren Co.

have an interesting exhibit showing single and double belting and supplies for the textile trade in general. The belts include waterproof leather, balata, etc., and an interesting installation of two belts running through water is shown. Split pulleys, belt dressing, belt fasteners and other accessories are included. This booth is featuring a very neat case which contains a collection of card clothing belts for woollen and worsted carding. These show the different size and style used in the various operations and over 30 samples are shown. This in itself is worth inspection and W. S. Hamilton, who is in charge of the exhibit invites anyone interested.

* * *

The Clipper Belt Lacing Co.

have a neat exhibit showing the many applications of their well known product. Mr. Logan is in charge of this booth and claims he is ready to meet all comers.

View at Canadian National Exhibition, Looking Towards Horticultural and Transportation Buildings.

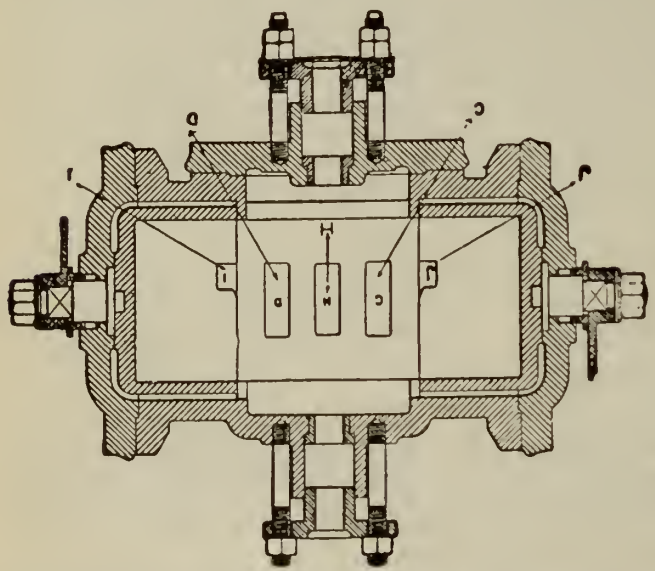
Overhauling and Adjusting in the Engine Room

Following Up Previous Articles, We Now Describe the Weir Feed Pump, Which Has a Steam Valve Differing From All Those Previously Discussed, Though the General Principle Remains

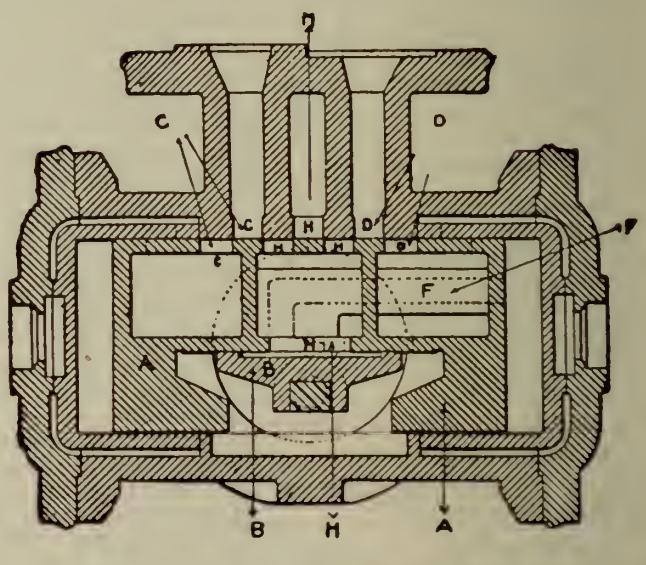
By "FITTER"

Following on the subject of simplex pumps, we will in this article describe a pump that is coming into use in Canada as a boiler feed pump for stationary plants. This pump, is widely known in marine work, there being probably more of them in use at sea than any other type of pump made. The steam valve of this pump is often thought by those unacquainted with it to be a terribly complicated affair, but it is just as susceptible to analysis as any other form of simplex valve. The pump alluded to is the Weir feed pump made in this country by Peacock Bros. Montreal, under license from the originators, Messrs. G. & J. Weir, Glasgow.

Like all other simplex pumps, the steam valve arrangement consists of a main valve and an auxiliary valve, the main valve being moved by steam delivered to it by the auxiliary valve, while the auxiliary valve itself is moved by the pump rod. In this pump however, the auxiliary valve also with its outer edge, cuts off the steam entering the ports to the cylinder.



Showing steam chest ports and valve caps.



Sectional plan showing general arrangement.

The main valve and the auxiliary valve are both slide valves, but the main valve has a half round face in communication with the cylinder while on the back of the valve the face is flat to form a seat for the auxiliary valve to work upon. The main valve has a horizontal motion, while the auxiliary valve works in a direction at right angles to the main valve, that is up and down across the face of the main valve.

Description of Valve

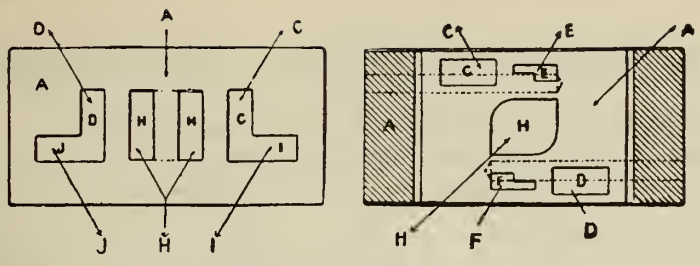
The valve will be described in detail, and in order to make everything clear we will take it piece by piece, afterwards describing the whole operation. The first illustration shows a sectional view of the cylinder face ports, with the caps in which the main valve works. As we have not mentioned these caps before we will do so now. They are actually small cylinders, into which the ends of the main valves fit like a piston. They are free to turn round in the steam chest, but cannot move longitudinally as can be seen from the illustration. They are held at one end by the steam chest end cover, and at the other by a shoulder formed on the steam chest. On the illustration a small spindle can be seen passing through the cover, and fitting into a slot in the valve cap or cylinder. This spindle is supplied with square or hexagon end, on which a spanner can be fitted to turn the cap round. This is necessary when using the by passes which will be explained later.

Looking at the illustration again, we see that there are three ports in the cylinder face, and these are as usual two steam and one exhaust port. The steam ports are C and D while the exhaust port is H. The two ports I and J are out on the caps, and are used as by-passes just referred to. We can now pass on to the main valve, and describe the ports on it.

The illustration showing the sectional plan of main valve, auxiliary valve, and caps shows the general arrangement of the steam chest. The main valve is marked A, and it will be seen that it fits in the caps at each end just like a piston in a cylinder, while the flat face formed on the back for the auxiliary valve is plainly seen. The auxiliary valve is marked B. It will be seen that the main valve face has four ports on the face communicating with the cylinder, two exhaust and two steam, the ports being lettered to correspond with the steam chest face ports.. The port F shown dotted is the port leading from the back of the main valve to the end, which admits steam to move the main valve. The other port E communicating with the other end is not visible, as it is above the section taken. The valve is shown in mid-position. The sectional view shows the semi circular form of the main valve to the spindle, while the ports E and F which communicate with the ends are plainly shown. If we now turn to the illustrations showing the front and back face of the main valve and the arrangement of the auxiliary valve, and observe the port arrangements, we will be in a good position to understand the operation of the valve as a whole.

The Main Valve Faces

The front face of the main valve, that is the face that works on the steam chest face has four ports cut in it. The two outside ones have a projection turned towards the edge of the valve, and these are the by-passes, that communicate with the opening in the cylinder or caps when they are turned round in the steam. Their function is to provide a supply of steam to the main cylinder after the normal point of cut off has occurred, when such supply is necessary to make the pump complete its stroke. The up and down portion of



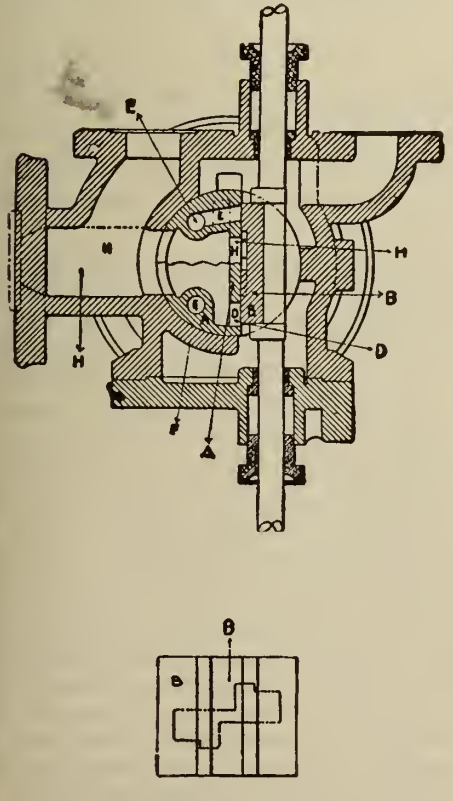
Front face of main valve and back face of same.

the ports C and D constitute the main steam ports, and the two inside ports H H are the exhaust passages.

Now on the back of the main valve, that is the flat portion on which works the auxiliary valve, we have five parts. Two af these, above and below central port H which is the exhaust port, are lettered respectively E and F, and their function is to supply steam to the ends of the main valve, and also exhaust steam from the ends of the main valve to allow it to move from the end of its chamber, and thus open the ports to the cylinder alternately to steam and exhaust. The other two ports C and D communicate through the body of the valve to the ports C and D on the inside face of the main valve.

The face of the auxiliary valve B has a capacity as shown by the dotted lines, which cavity gives communication with the exhaust ports from E and F alternately to allow the steam at the ends of the cap to be exhausted. The outside edges of the auxiliary valve also cut off steam from C and D as the valve moves up and down with the movement of the pump.

In the view showing the general arrangement of the valve the main valve is shown in mid-position, and steam



Sectional elevation above, auxiliary valve below.

and exhaust valves are closed. This condition never occurs in practice, as the valve must be either at one end of its stroke or the other. Let us suppose that the valve is at the right hand end of its travel and the port C is open to steam. This port leads to the bottom of the cylinder, and the piston is at the bottom of the stroke, about to commence its upward movement. The piston will move up, and when it reaches approximately its half stroke, the lever which is attached to the pump rod, will come up against the nuts on the valve spindle rod, and start to move the auxiliary upwards. When the piston has reached three quarter stroke the outside edge of the auxiliary valve will have cut off steam from the port C while as the auxiliary continues its upward movement, the port E will be laced in communication with the exhaust, and F with steam, when the main valve will move over, and give steam to the other end of the cylinder. It will be noted that the steam has been cut off from the main valve when the piston is at three quarter stroke, so that the stroke must be completed by the expansion of the steam under the piston. If the cylinder is cold, or the initial pressure weak, the piston will not complete its stroke, so that some help must be given it. The caps at the end are turned round in the chest until the by pass comes in line with the extension of the steam port on the steam valve face and thus live steam is supplied to complete the stroke. If these by-passes are proper working condition however, these by-passes must be closed, otherwise the pump will knock heavily at each end of the stroke. If these by-passes are properly looked after the pump will slow down at the end of its stroke come gradually to rest, and start off again without a sound.

The movement of the auxiliary valve is controlled by the position of the nuts on the valve spindle rod, and it is easy to see, that the closer together these are the sooner will the auxiliary valve start to act. The nuts are fitted with lock nuts, and they are easily adjusted when the pump is started, if they need any. The easiest way is to open the by passes, and giving the pump a little steam, adjust the nuts until the pump starts readily from each end. This shows that when the pump is at the end of the stroke, the auxiliary valve has been moved far enough to throw the main valve. The by-passes can then be throttled down and the full steam given to the pump, when any further slight adjustment should be made.

The ends of the spindles by which the caps are turned are secured by a lock nut, and the spanner which is supplied is also arranged with a slot in the end, which can be used for moving the valve spindle in starting the pump. This spanner should be used in just this way, and not as a means of hammering the pump under the mistaken notion that abuse will make it go.

The maintenance as far as the steam valve of a Weirs pump is concerned is of the slightest. It should be examined from time to time, and if necessary faced up like any other slide valve. However, if it is scraped up from time to time, it will be necessary to insert a liner between the back of the auxiliary valve and the valve spindle to keep their relative positions the same as when the pump is new. A little oil from time to time is necessary, and the makers usually furnish a special lubricator for this purpose. With ordinary care and intelligence, the operator will have nothing to find fault with in the operation of these pumps. We have heard complaints from engineers about their performance but have found invariably that the fault was not with the pump.

SOMETHING NEW IN WINDMILLS.

Many attempts have been made to solve the problem of efficiently utilizing the winds as a means of generating electricity. The difficulties arise from the extreme variations in the force of the wind and from the liability, even in windy regions, to periods of calm during which no power at all can be obtained. These conditions suggest that wind power should be used only as an auxiliary to some other source of energy, such as the burning of coal or oil. Now that fuel of all sorts has multiplied in price there is all the more reason for considering the possibility of turning the wind to account. Hitherto the usual plan has been to use a large slow-speed windmill to drive a dynamo at a high speed through gearing—a rather wasteful arrangement. During the war, however, there was in Great Britain a remarkable development in the design and construction of small high-speed dynamos on aeroplanes. These dynamos were direct-coupled to propellers or rather "impellers," driven by the wind created by the aeroplane in flight. A British firm has devised a scheme for fitting three or more of these wind-dynamos on the swivelling top of a vertical pole; with a vane to keep them in position against the wind. Each equipment gives 60 watts, and the arrangement forms a cheap and efficient auxiliary to the ordinary country-house lighting installation. The energy produced is, of course, stored in accumulators in the usual way. The operation of the plant is entirely automatic and it is so light and simple that it presents no obstacles in erection and maintenance.

The Internal Combustion Engine Discussed

The Two Cycle and Four Cycle Types with Their Advantages and Disadvantages are Mentioned by the Author, Who, However, Displays a Great Leaning Towards the Two Cycle Type

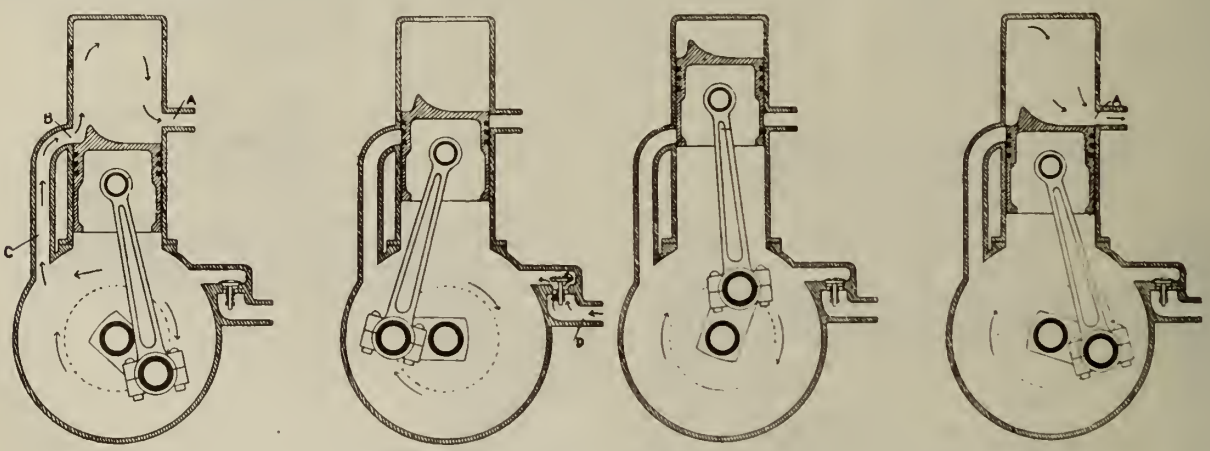
By A. W. BRADBURY

IN the reciprocating steam engine, power is derived by the admission of steam under considerable pressure into a cylinder behind a piston which is driven outward by expansion of the steam, and, through a connecting rod and a crank, this piston thrust rotates a shaft connected direct or by belt or gears to the object to be moved. In this process no chemical action takes place within the steam cylinder. All chemical action occurring in the generation of steam power is carried out in the fire under the boiler and the power stored in the boiler in the form of steam under pressure. The action of the steam engine itself, in using this stored power, is purely mechanical.

gas burned under a boiler to generate a given quantity of power in a steam engine will supply more than twice that quantity of power if consumed in an internal-combustion engine. Coal cannot well be employed as fuel for an internal-combustion engine unless first finely pulverised, hence the fuels for these engines are found in the liquid or gaseous form. If the fuel be a gas it is mixed with air and drawn into the engine by the suction of the piston, the mixture is compressed in the cylinder by the inward stroke of the piston and then ignited by an electric spark. Combustion of the mixture is practically instantaneous the resulting heat causes rapid and intense expansion of the contents of the cylinder and this expansion forces the piston outward on its power stroke.

one cylinder and by expansion in one cylinder against compression in another in multi-cylinder engines.

One expansion stroke and one compression stroke together constitute a cycle, in the two-stroke-cycle type of engine. In this form every outward stroke of the piston is a power stroke, every inward movement a compression stroke. here the burnt gas must escape and the fresh charge of air and fuel must enter the cylinder while the piston is at or near the outward limit of its traverse. This necessitates a rapid emptying and refilling of the cylinder. In engine parlance the process of ridding the cylinder of the products of combustion, i.e., steam, carbon dioxide, and other inert gases, and replacing them with fresh air or air and fuel mixture is termed scavenging the cylinder. In a two-stroke engine the cylinder is scavenged with every revolution of the flywheel.



FIGS. 1, 2, 3 and 4.

Diagrams 1 to 4 show a two stroke cycle engine in sections, in which Fig. 1 indicates the position of the ports when scavenging is taking place with exhaust gas escaping on the right, while a fresh charge is entering the cylinder on the left, through the by-pass from the crank case.
Fig. 2 shows inlet and exhaust ports closed by the piston on its upward stroke, with inlet valve in crank case open to admit a mixture of gas and air or of air only into the crank case.
Fig. 3 shows the piston moving downward under pressure of the expansion stroke and at the same time compressing the ensuing cylinder charge in the crank case.
Fig. 4 shows the exhaust gas beginning to escape before the piston has gone down far enough to open the inlet port on the left. The opening of the latter takes us back to Fig. 1.

In the internal-combustion engine both mechanical and chemical action take place wholly within the cylinder. Creation of pressure, heat, and expansion, in this order, all take place within the cylinder behind the piston and drive it outward or downward just as steam drives a piston.

In both cases the fuel consists of carbon and hydrogen, principally the former, mixed with the oxygen of the air in such proportion as to support combustion of the fuel elements. In the generation of steam power, coal, coke, and wood are convenient fuels and are the fuels generally employed, but liquid or gaseous fuels may be used, and are used. But this process is wasteful because of the quantity of oil, alcohol, or of operation" of an internal-combustion

At or near the end of the outward stroke of the piston the nearly spent gases are allowed to escape from the cylinder, through an exhaust valve or a row of ports, and a new mixture of air and fuel, or air only, is taken into the cylinder to be compressed ready for the next power stroke. The "Scheme engine is one of "alternate expansion and contraction"—expansion being caused by heating and contraction by cooling the contents of the cylinder, such cooling taking place very rapidly upon release of pressure on the gases by the opening of the exhaust outlet. The compression of the charge also constitutes a form of forced contraction, the force for which is supplied by the momentum of the flywheel in engines of

In this type of engine, scavenging is attained usually by two rows of ports in the cylinder barrel, placed opposite each other, the ports on the exhaust side being higher, or deeper than those on the inlet side. During the greater part of the stroke these ports are covered, and, therefore, closed, by the piston. As it moves outward on the power stroke the piston first uncovers the upper or inner portion of the exhaust ports and the burnt gases above the piston, still under pressure, begin to rush out. With the sudden release from pressure the exhaust gas contracts enormously. While it is rushing out, with the piston moving all the time and in-

*By A. W. Bradbury and read at a meeting of the Institute of Marine Engineers.

creasing the area of opening of the exhaust, the piston begins to uncover and continues to enlarge the inlet openings, whereupon the fresh charge of air, or air and fuel flows in through these. The escape of the burnt gas is continued through the momentum set up in the mass before the uncovering of the inlet ports, and this momentum would cause a partial vacuum in the cylinder if the inlet ports were kept closed. The entrance of the fresh charge is induced partly by the fall of pressure within the cylinder and partly because this charge itself is under pressure, for so it has been taken into the crank case during the inward movement of the piston and there compressed to a few pounds above atmosphere by the outward movement, the piston thus acting as a pump attached to the crank case. A by-pass connects the crank case with the inlet ports, through which the fresh charge flows to the latter. If nothing were done to prevent it, the incoming fresh charge probably would flow straight across the top of the piston and out through the exhaust ports. To obviate this a baffle ridge or plate is formed on the top of the piston, so shaped that it directs the inflowing charge toward the top of the cylinder.

Thus we find in the cylinder at the same instant two currents flowing in opposite directions, one composed of incombustible gas flowing downward and outward, the other of air or combustible mixture flowing inward and upward.

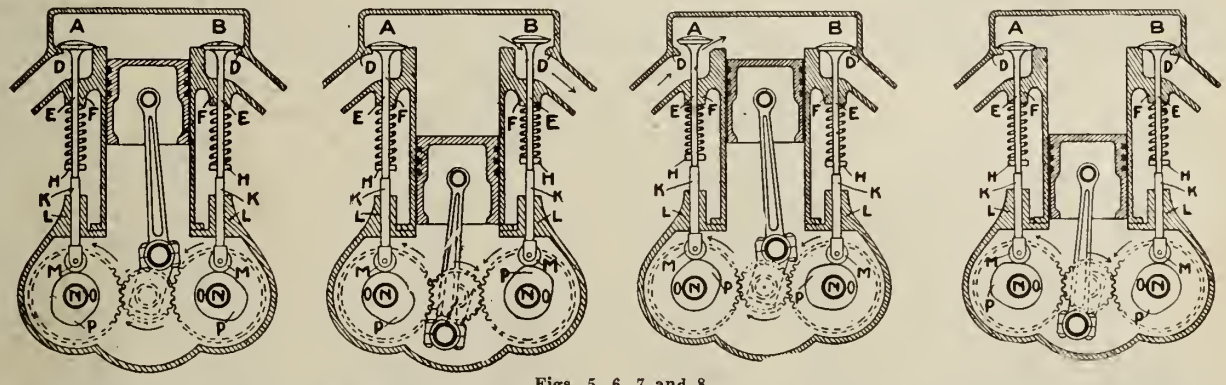
Various schemes have been put forward for improving the scavenging of two-stroke cycle-engines, in which the two rows of ports have been retained in the same end of the cylinder. Only one of these schemes appears to have proved of sufficient value to justify its retention in view of the increased cost of an engine so fitted. This consists of an auxiliary row of inlet ports, situated above the regular ports, through which additional air can be forced into the cylinder after the exhaust ports have been closed. This plan does increase the volumetric efficiency of the engine. But how can it improve scavenging per se?

The period of time during which scavenging must take place in a two-stroke engine is very short. The general rule is to make the area of the exhaust ports such that they allow for a gas movement of forty-five feet per second, based on piston volume and speed of rotation, and the inlet area large enough to permit the air to pass at eighty feet per second. If we follow these rules in an engine running at three hundred revolutions per minute, or five revolutions per second, and if the exhaust ports be open during one hundred and twenty degrees of the crank path, the gas must escape in one-third of one-fifth of a second, that is, one-fifteenth of a second, or fifteen times forty-five feet per second which equals 675 feet per second. The same ratio of port area to piston volume and speed should be maintained in other sizes running at other speeds, and such areas are ample.

The latest attempt to solve the scavenging problem in the two-stroke engine consists in a uniflow arrangement in a single-acting cylinder, in which the top of the piston is perfectly flat and the exhaust ports extend clear around the cylinder barrel, maintaining the pressure on the piston throughout nine-tenths of its stroke, and the fresh charge is admitted at the other end of the barrel. Theoretically this should increase the power and should be more economical of fuel than is, say a submarine engine in which the exhaust ports are uncovered whn the piston is only three-quarters of the way out on its stroke.

In the four-stroke-cycle engine we have exhaust gases escaping, and a fresh charge entering the same end of the cylinder but not at the same time. Instead of completing the cycle in two strokes, we have here two inward and two outward movements of the piston in which to complete it. This system enables the cylinder to be properly scavanged without any intermingling of opposing currents. Here the piston plays the part of a pump within the cylinder itself, and the crank case has nothing to do with the cycle. Beginning with a power impulse, the piston moves outward. At or near the end of the outward stroke a valve opens in the top of the cylinder and the returning piston pushes the burnt gas out through this valve. About the time the piston returns to the starting point this exhaust valve closes, and an inlet valve opens, which is in communication with air, or air and fuel. The piston then moves on its second outward stroke and draws air and fuel through the inlet valve into the cylinder. At the end of this stroke the inlet valve closes. Both valves being now closed, with the fresh charge imprisoned in the cylinder, the second inward stroke of the piston compresses the charge, which ignites and starts the piston outward on a new cycle. Scavenging is not so hurried here as it is in the two-stroke engine. One whole inward movement of the piston is given to forcing exhaust gases out of the cylinder. One whole outward movement to inducting a fresh charge, thus the four-stroke engine spends half of its time in compressing, firing and expanding the power charge, and the other half in pumping out burnt gas and pumping in air and fuel. It gives us one power impulse to every four strokes of the piston. The other type, one power impulse to every two strokes of the piston. If the two types run at the same number of revolutions per minute, the two-sroke engines fires twice as many charges of fuel in the same period of time as does the four-stroke. If the pressure on the piston was carried as far out in a two-stroke engine and if scavenging were as thorough, we would expect this type to develop twice the power of a four-stroke having the same cylinder capacity and the same speed of rotatioon. But it doesn't do it.

Thus far we have dealt only with two-stroke engines in which the scavenging is accomplished through ports only, and with four-stroke engines in which scavenging takes place through mechanically-operated valves. We now come to a modified form which is a two-stroke engine, so far as the cycle is concerned, but which employs mechanically-operated valves in the scavenging. In this form the usual exhaust ports are found, and they function in



Figs. 5, 6, 7 and 8.

Fig. 5 shows the piston moving outward on its expansion or power stroke with both valves closed. In Fig. 6 the piston has started upward with the exhaust valve open to permit the escape of burnt gas, pushed out by the piston. Fig. 7 shows the piston moving downward on the suction stroke with the inlet valve open to admit a new charge to the cylinder. Fig. 8 shows the valves now closed and the compression stroke commenced.

the usual manner. In addition there is placed in the cylinder head a scavenging valve, mechanically operated and communicating with a supply of air under pressure. On the power stroke of the piston, shortly after the upper edge of the exhaust ports is uncovered, the air valve is opened and the compressed air blows the exhaust gases out. This valve then closes before the piston has fully covered the exhaust ports again This arrangement assures satisfactory scavenging, but at the cost of an air pump with its connections, in addition to the cost of the valve and its operating mechanism. Still, in large engines, where the added cost bears small relation to total outlay on the plant, this method of scavenging has been found to be commercially practical. When the same results in scavenging can be attained in all types of two-stroke engines, large and small, without the extra air pump and valve operating mechanism, we shall have made a step forward in two-stroke design which which will be of greater value than any other improvements made in this type in many years. For undoubtedly the weakest feature of the two-stroke heretofore has been in the scavenging of the cylinder.

Such an improvement can be made, and in fact has been made. An engine embodying it will shortly appear in the field. With the scavenging bugbear removed, the prejudice against crank case compression still remains,at least in the minds of those who have not had extensive practical experience with the actual working of two-stroke engines. The cry of the uneducated is that you cannot see what is happening to the big end when closed in out of sight. The answer is that nothing happens to it. Another answer is that the big end is not throwing oil all over the place when closed in. But the man with the big phrenological bump of prejudice says the main bearings throw oil which the compressed air in the crank case forces outward. The answer to this is that they don't, if very simple precautions be taken to prevent it. Another complaint is that the automatic air inlet valves in the crank case cause trouble. Wrong again; if they are properly made, and not all two-stroke engines have them. Some have a third port uncovered by the piston when near the top of its stroke to admit air to the crank caes. Either arrangement is satisfactory.

The three port crank case compression, two-stroke engine is valueless. It is the simplest engine extant. Simpler than the simplest steam engine. It originated in England as a petrol engine. The inventor of the tuo-stroke petrol engine issued licences to firms in foreign countries, one of which built and sold over sixty thousand two-stroke engine prior to 1912.

Two-stroke engines have been in operation in every country in the world for more than two decades, the total number long ago exceeding the million mark. While such large numbers of them have been finding their way into every corner of the earth, British builders have stuck to the four stroke type. They have not expended money or energy in the development of the two-stroke. Had they done so there would to-day be less prejudice against this type. Power for power the two-stroke is cheaper to build, lighter in weight, occupies less space, and requires fewer repairs than a four-stroke. The popularity of the semi-Diesel and the success of the larger Diesels operating on the two stroke cycle are gradually bringing the two-stroke engine into its own.

It requires no valves, no valve springs, no tappets, no cams, no cam shaft, no half-time gear, no cam shaft bearings, no valve cages. Deduct the expense of these from your four-stroke job and see the difference in first cost. Or add the cost of these to a two-stroke engine and see how much more it costs. Then in running you have no valves to grind, no tappets to adjust, no gears to set in time, no cam shaft bearings to oil, none of these things to go wrong. In the four-stroke you have just two items to set against these advantages in the two-stroke, viz., a slightly lower fuel consumption and slightly better flexibility. With improved scavenging the difference in fuel consumption will become practically nil and the difference in flexibility is not a vital point. If the two-stroke-cycle engine were not satisfactory to those who use them to earn a living we should not find twenty semi-Diesels of the two-stroke type to one of the four-stroke. And unless those who devote their lives to the design of engines were not satisfied that the two-stroke is perfectly practical from every standpoint we should not see one large two-stroke Diesel after another rapidly coming into competition with the already established four-stroke machines.

In gas, petrol, and paraffin engines, where the fuel is mixed with air before admission to the cylinder, throtling is accomplished simply by a reduction of the quantity of mixture taken in on the suction stroke, by a butterfly valve placed in the induction pipe. This valve controls the quantity of air admitted, and since the quantity of fuel entering the cylinder depends upon the air current; the richness of the mixture is not greatly affected by the action of the throttle valve. And because the charge is fired by an electric spark, ignition is certain.

But in an engine in which air alone is drawn into the cylinder to be compressed and the fuel forced into the air charge when compression is far advanced, the case becomes entirely different. In the Diesel engine where we depend solely upon the heat of compression to fire the charge, it is evident that to throttle the charge of air would be to reduce the compression, lose that heat and fail to fire.

In the semi-Diesel engine ignition is brought about by a "hot spot," which depends upon obtaining its heat partly from compression. True, it is the burning of the fuel which raises the temperature of the hot spot to redness, but because it is already warmed to a considerable degree by the heat of compression, the explosion heat carries it on up to a temperture at which it ignites the fuel. Take away the heat of compression and the hot spot sooner or later cools down to a point where it will not fire the charge, and this is what happens when we reduce compression by throttling the air inlet.

In this type of engine the compression of the air varies more than in any other type. In some semi-Diesels compression is as low as nine atmospheres, isothermal In others it is as high as eighteen atmospheres. In two or three engines it is still higher. The average semi-Diesel compression is perhaps in the neighbourhood of 150 lbs. per square inch isothermal or, say, 210 lbs. adiabatic, if we disregard the effect of the cooling water. Owing to the rapid compression, and the rapid repetition of compressions in running on full load, the cooling water probably does not affect the adiabatic temperature to any marked degree. If the air be uncooled, rapid compression of it to 150 lbs. per square inch raises it to a temperature of 589 degs. Fah., if taken into the compressor at a temperature of 60 degs. Fah. Such a temperature is high enough to vaporise any of the mineral oils used as fuel in an oil engine. Presumably such compression also raises the temperature of the hot spot to a corresponding degree. The design of the engine is such that the heat of combustion will then add to the hot spot the heat required to raise it to the point where it ignites the oil, and maintain it at that temperature, even when the engine is running light. It is obvious that if we throttle the air inlet in an engine of this type the heat of compression will be very much reduced. If we reduce compression to 100 lbs. per square inch we obtain an adiabatic temperature of 485 degs. Fah. In reducing the pressure 50lbs. we have reduced the temperature 104 degs. If the hot spot be reduced 100 degs. in temperature, irregular firing is sure to follow and soon after it will fail entirely.

In order to run on part load or no load it is better to go on compressing the full quantity of air at every revolution, and thus retain all the heat of compression, and to regulate the speed of the engine by reducing the amount of fuel fed. We pay no attention to mixtures, "rich" or "lean," in the semi-Diesel engine, nor in the true Diesel, for that matter. There is always in these engines a quantity of air in excess of that required for combustion, so that, in governing them, we are not obliged to reduce the air when fuel is reduced, nor to increase the quantity of air to meet an overload. Another point to be remembered is, that all power expended in compressing air in the cylinder is returned

in the rebound of the compressed, and, therefore, heated, mass. In a few makes of semi-Diesel engines an arrangement is fitted for throttling the air in the by-pass between the crank case and the cylinder. On the other hand an engine brought out recently has a valve which prevents air from entering the crank case until the piston is part way on its inward movement, and so has created a partial vacuum in the crank case. The valve then opens, permitting the air to enter with a rush, which continues until the air in the crank case exceeds atmospheric pressure, upon which the valve closes and the return of the piston compresses this air ready for scavenging the cylinder. The same effect could be produced in the ordinary three port engine, possibly, by increasing the area of the crank case inlet ports circumferentially. The effort to get air into the crank case above atmospheric pressure certainly seems more reasonable than to reduce the scavenging air by throttling it. Not less scavenging air, but more is what we want in the ordinary, two-stroke semi-Diesel engine, in which both the exhaust and inlets ports are in the same end of the cylinder barrel and are both open at the same time. In this type we do not lose any fuel in scavenging, as may occur in those engines where the air and fuel mixture is employed for scavenging. If we can get enough scavenging air through the semi-Diesel cylinder to sweep out all of the burnt gas, we shall then compress nothing but pure air. We can then burn more fuel than we do where a certain quantity of burnt gas remains mixed with the fresh air charge.

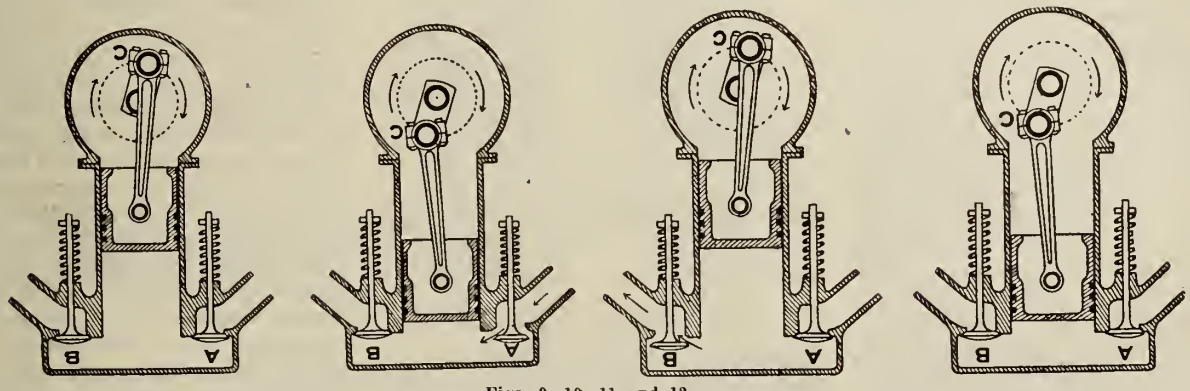
Fuel injection valves are employed in all makes of Diesel engines and in a large proportion of the semi-Diesel type. In the Diesel engine the injection valve is arranged to retain within the nozzle the fuel required for each charge until the proper instant for injection, then to lift and permit the fuel to be blown into the cylinder by an air blast under a pressure of 900 to 1,000 lbs. per square inch, through a series of staggered holes in thin steel plates fixed in the fuel nozzle. In this case the fuel pump exerts no pressure save that necessary to deliver the oil into the nozzle space surrounding the injection valve. The latter when closed prevents both air and oil from entering the cylinder. At the proper point in the cycle the valve is opened mechanically and the air blast effects the injection. In such case the fuel nozzle possesses a single, central opening and the valve is tapered to a needle point, to plug the opening when the valve is closed. In Diesel engines having a so-called solid injection the arrangement is different. Here no air blast is used. Instead of air a resilient fuel pipe is employed and the fuel forced into this by a ram pump to a very high pressure. This fuel supply pipe is made of thin, high tensile steel, is oval in section, and extends along the side of the cylinders, with a small branch pipe leading to each injection valve. The tips of the fuel nozzels are hemispherical in shape and each contains several very small holes, which diverge somewhat from the centre line, and communicate with a central hole. which is plugged by the fuel valve. The pumping of fuel into the oval pipe to a pressure of something like four thousand and in some cases even as high as 8,000 lbs. per square inch, causes this pipe to spring outward on the direction of its shorter diameter, that is, the high pressure tends to spring its flat sides outward and make the section more nearly round. Then when a fuel valve opens and thus relieves the pressure somewhat, the return of the pipe toward its original shape is the force which injects the oil into the cylinder.

In the semi-Diesel engine, lower fuel pressures are involved because the compression pressures in the cylinders are not so high as in the true Diesel. The greater number of semi-Diesels have fuel nozzles in which there is a single central spray hole. Just a plain round hole in the smaller sizes and a hole with rifles in it for the larger cylinders. In calculating the size of this hole the volume swept by the piston is the basis upon which to work, regardless of the speed of the engine. For example, a swept volume of 300 cubic inches would require a spray hole about fifteen thousandths of an inch in diameter. The shorter the hole, that is, the thinner the metal through which it is drilled, the better the atomization of the oil, for a long hole through thick metal tends to wire-draw the oil and feed it in a thin stream. In some engines having fuel nozzles of this type a simple check valve is placed as near to the point of the nozzle as possible, while in others no valve is put in the nozzle. In the latter a short, sharp stroke of the fuel pump is relied upon to break up the oil at the spray hole. Other engines have a needle valve, spring loaded, which is opened by the pressure of the fuel oil, and this is better, because less likely to permit any dribble of the oil at the finish of the injection.

Whatever the form of spray hole and whether valveless or not, the fuel nozzle should always be well water-cooled, and unless is contains a valve it should always be inclined upward at a considerable angle above the horizontal, to prevent air locks and to guard against dribbling of the fuel at the end of the injection. An air bubble at the fuel line anywhere between the pump and the nozzle is fatal to regular running of the engine. For this reason every fuel nozzle must be designed and mounted in such a way that air locks cannot by any possibility occur.

If injection nozzles and valves be properly designed and carefully made; if they be throughly water-cooled; if they be mounted properly, and if their connections are all they should be, they are not likely to give any trouble except from dirty fuel. This is the cause of most of the trouble arising in this particular fitting. It is essential, then, that fuel filters be ample in number and made of gauze fine enough to strain out all particles of dirt large enough to choke the spray hole or interfere with the seating properly of the injection valve. . If the mesh of the gauze be smaller than the spray holes, and if strainers be cleaned frequently, no dirt is liable to reach the spray holes. And yet, when an engine stops suddenly without apparent cause the first rule is, look for dirt.

There is a type of engine, known on the Continent of Europe as the Brons and on the Western Continent under half-a-dozen diferent names, in which no force is required to feed the fuel. Hence the function of the injection valve is



Figs. 9, 10, 11 and 12.

Fig 9 shows the piston moving downward on the power stroke, both valves closed. Fig. 10 shows piston moving upwards with the exhaust valve open to admit of the escape of burnt gas. Fig. 11 shows piston moving downward on the suction stroke with exhaust closed. Fig. 12 shows piston starting upward on compression stroke with valves closed. The charge is then fired and the cycle repeated.

solely to measure the charge. In this type of engine a small shell cup is placed in the combustion chamber, having a number of fine perforations in the sides. On the suction stroke of the engine the fuel is deposited in this cup, and on the return stroke of the piston it is vaporised and ignited by the heat of compression. This, of course, involves compression pressures practically as high as those found in the Diesel engine.

As to what actually takes place in the Brons cylinder, the theory is that the rising heat of compression first vaporises a small quantity of fuel in the cup then ignites it, and the tiny explosion following blows the balance of the fuel out through the fine holes in the cup into the cylinder where it burns. We may not be able to agree with this theory but the fact remains that the Brons engine works beautifully, is economical of fuel, burns any grade of fuel that the Diesel does and is much simpler in construction than the latter.

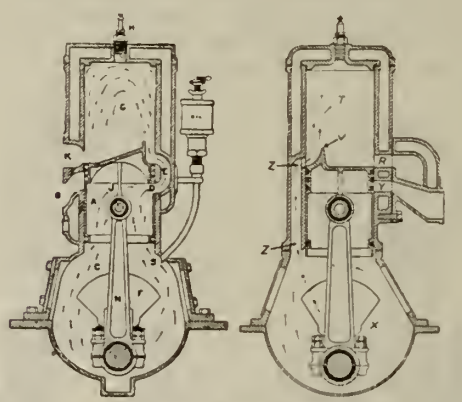
Fuel pumps of plunger pattern are, of course, necessary for supplying fuel under pressure to any type of oil engine. They are of two varieties, one of which has a suction valve on one side of the single plunger and a discharge valve on the other. Where balls are used as valves we sometimes find two on each side of the plunger—an indication that the designer does not have full faith in a single ball valve. And he should not have. The strongest argument in favour of a ball valve is that it is cheap. The other variety of fuel pump has two plungers, the secondary one of which is controlled by the governor in such a way as to keep the suction valve open for a shorter or a longer period, according to the quantity of fued required to correspond with the load on the engine. With the single plunger pump, governing is secured by varying the length of stroke of the plunger. Whatever the style of pump, it should be made of proper materials and the workmanship should be as nearly perfect as it is possible to attain, for the fuel pump is the heart of the engine. As to whether fuel pumps should be packed, those of wide experience hold opposing views on the question. A pump properly packed should work for years without leakage.

Fuel pumps can be made, and are made, which work under pressures of several hundred pounds per square inch for long periods without showing any sign of leakage and without any packing whatever.

Small oil engines, up to about fifteen horse power, are started by hand, by pulling the flying wheel against compression. These cannot be started by revolving them in the direction of running, whether they be two-stroke or four-stroke, because ignition cannot be retarded, as is don in an electric fired engine.In pulling against compression the charge fires before the piston reaches top centre and starts the engine back the other way.

Stationary engines having large flywheels with spokes require no other device for starting them. Using the spokes as handles, the flywheel is thrown against compression, that is to say, it is given as much momentum as possible and the operator lets go just before the engine fires. For if he holds on until the charge ignites he may receive a sprained wrist.

In marine engines having flywheels of disc pattern the best provision for starting by hand is the fitting of a disappearing handle in the rim of the wheel. By hooking three fingers over this handle and pulling against compression until the firing of the charge jerks the handle away from the fingers, the engine starts at the first pull and the operator runs no possible risk of injury, for the handle flies in flush with the wheel the instant it is freed from the hand. Such a handle is useful also for turning the engine over, in sizes too large to be started by hand. In still larger sizes, where more leverage is necessary to turn the engine, holes should be provided in the face of the wheel rim into which a bar may be inserted, but these holes should not extend entirely through the rim. If they do there is danger of shoving the bar too far through and failing to get it out quick enough if the engine fires. The bar is not to be used for starting the engine, but only for turning into position for starting, but sometimes when turning an engine over while hot, it will fire unexpectedly. The cranking bar should be made specially for the purpose, straight on one side and rounded longitudinally on the other, so that only the straight or flat side can bear against the side of the hole. It should have a projection or hook on the rounded side to bear against the face of the wheel. If the wheel should then move suddenly in the direction it is being turned the bar will be forced out of the hole. Relief valves in cylinders should always be opened before trying to turn a warm engine.



Figs. 13 and 14.

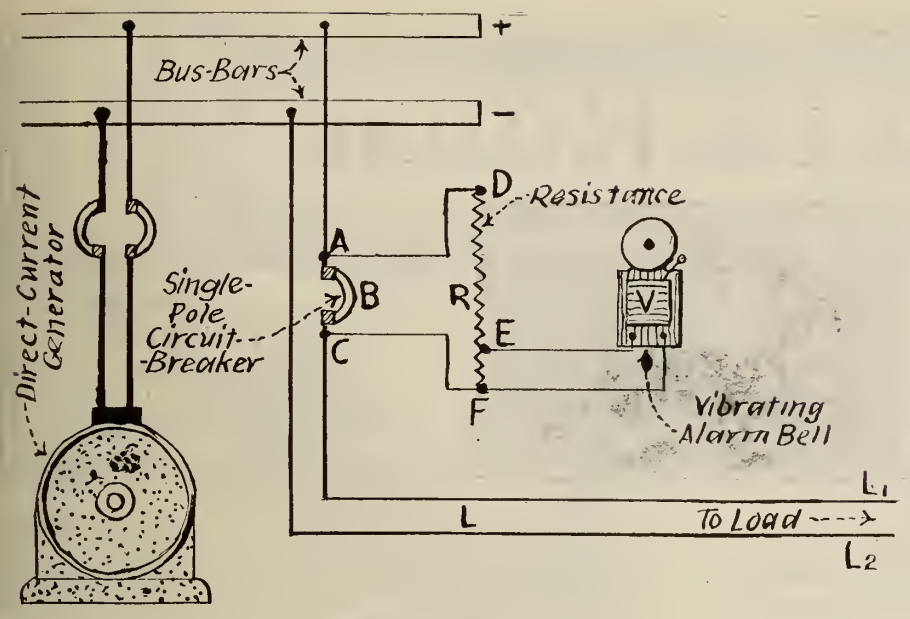
These diagrams illustrate a three port two stroke engine. Fig 13 shows the position of the ports during scavenging. Fig. 10 shows the piston about to start the stroke and thus opening the port to admit a charge to the crank case.

In engines too large to be started by hand, compressed gas or compressed air is generally employed: The gas is accumulated while the engine is running, through a special valve fitted in the cylinder and connected to the starting tank. The objections to this system are: 1st., that the connecting pipe gets hot; 2nd., the valve stems sometimes stick, owing to the heat and to the impossibility of lubricating them; 3rd., carbon deposits form on the valves of the connections. causing loss of compressed gas by leakage. For these reasons compressed air is preferable, as it has none of these drawbacks. Accumulation of the air is best obtained by means of a small air compressor attached to the engine. This need not be large enough to require water cooling. It runs while the engine is running and stores air enough for starting purposes. It should be fitted with a relief valve or, better, with a three-way cock, so that is can be relieved from compression air when the pressure in the tank is as high as required. Of course, neither gas nor air can be accumulated by an engine for starting the first time, nor for starting it in the event of the pressure tank having been emptied by a leak. This makes necessary an auxiliary arrangement of some kind and this generally consists of an air compressor worked by hand, for filling the air tank for the first start. But the compression of air by hand is an extremely slow and laborious process and it should be avoided if there is any possible way of obtaining other power for the purpose.

In an engine of two cylinders starting air should be supplied to both, and in a four-cylinder machine to two at least. In those engines manoeuvred by compressed air it is, of course, supplied to all cylinders, or should be. The air should be controlled by mechanically-operated valves which will admit the air only through that portion of the piston stroke which is most effective, say, from about top centre through an arc of crank path of about 90 degs. To go beyond this is unnecessary and also wasteful of air. The function of the compressed air or gas is simply to give sufficient momentum to the flywheel to carry it over until the engine fires, and the air should be shut off as soon as it fires.

NEW MATERIAL

A new plywood material used for aircraft construction has made its appearance on the English market. This material, according to reports, should not be confounded with ordinary plywood, for it is something infinitely superior. It is said to be a super-plywood, which is actually sewn together. The layers are first cemented together with waterproof material and then stitched through in parallel rows about 1¼ inches apart. This gives a rigidity and resilience unattainable by any other method. Weight for weight, it is the strongest material yet evolved. The sheets are made to any desired size or shape up to 8 feet wide by 60 feet long, and from ⅛ inch to ⅝ inch thick, thus eliminating waste in the conversion.



Circuit Diagram For Alarm Bell

A SIMPLE POWER ALARM

By L. C. Harding

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In a certain plant, electrical power was transmitted over a line L, which was of considerable length. Delay often ensued in closing the power-station circuit-breaker (B, Fig. 1) after an overload had occurred at the far end of the line. The delay was due to the fact that the duties of the station engineer were such that he could not remain permanently in the power house to watch the circuit breakers. Consequently an automatic alarm to notify the engineer of the opening of the breaker, was improvised as shown. The circuit-breaker, B. which protected the line, was of the single-pole type. A resistor, DF, of high resistance was arranged in parallel around the circuit-breaker from the points A and C. Then an ordinary vibrating bell was connected across a portion of this resistor, as shown in EF. When the circuit-breaker is closed, practically no current flows through DF or through the electric bell, V, because the path AC, through the circuit-breaker, offers much the least resistance. However, if the circuit-breaker is now thrown open, because of an overload on L, then current will flow through DF and through the bell, V, provided the line, L1 L2, is closed at the load end by a machine being connected across it, or by some other conductor. With the circuit-breaker, B, open, if the vibrating bell rings continuously, it indicates a short circuit at the end of line L. The bell will continue to sound until the circuit-breaker is closed. This audible signal attracts the attention of the operator, who then closes the circuit-breaker.

FINDING TROUBLE WITH A LAMP IN A FUSE BLOCK

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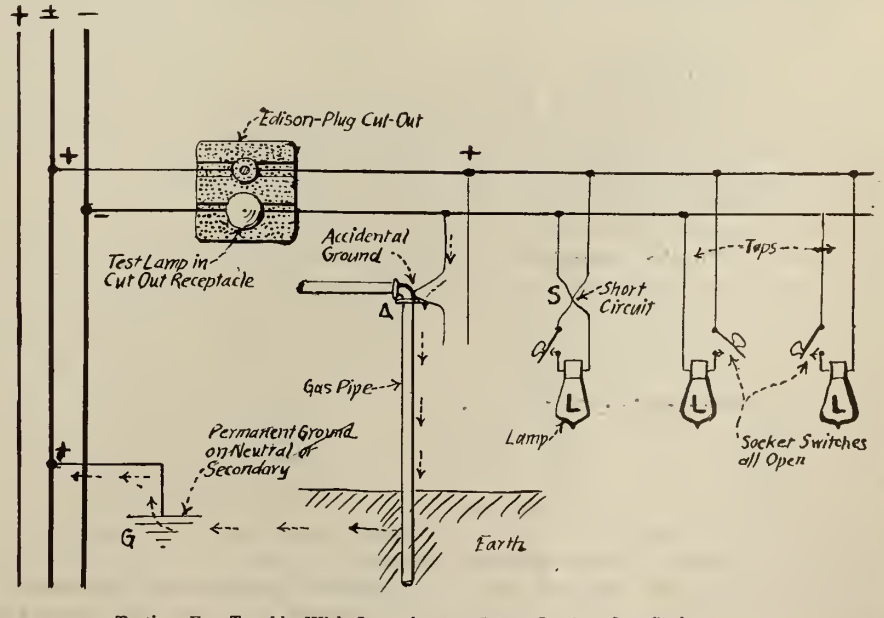
An incandescent lamp can be used as a "test lamp" for testing out incandescent-lamp circuits. This test lamp is screwed, by the wiremen, into the Edison plug-type cut off or fuse block. When tests are being made in this way, the incandescent lamp, L, is inserted in the receptacle (on the ungrounded side of the circuit) of the cut-out, through which the circuit is fed. The lamp serves not only as an indicator, but also as a resistor which limits the current through the circuit. In case of a short circuit, as at S, the lamp will light. Or with a ground as at A, the lamp will light also. Trouble can thus be located by first putting the lamp in the service entrance cut-out plug and with all of the branch circuit connected. In the case of a ground or short circuit, lamp will light. Then both sides of each of the branch circuits are successively opened until the lamp goes out. This localizes the trouble to a single-branch circuit. Now the difficulty can be further localized by screwing the indicating lamp in the cut-out which serves the branch circuit, making test as above suggested.

In making trouble locations by this method, all of the incandescent lamps or their receiving devices on the circuits under test must be opened by the socket or individual switches, through which they are fed. The underlying principle of finding the trouble is that of elimination. With the test lamp in position in the cut-out, disconnect circuits or part of circuits until the circuit or the part of the circuit in which the trouble exists is identified.

SIMPLEX ROOF FLASHINGS

A booklet on "Simplex" galvanized iron, copper and all lead flashings has been issued by the Simplex Mfg. Co., Chicago, Ill., and can be obtained from their agents, W. H. Cunningham & Co., 269 West Richmond St., Toronto, Ont. Simplicity, durability and efficiency are claimed for this flashing, which consists of only three parts—the flange plate or base—the cone shaped sleeve—and a pure lead collar. It is stated that these flashings will fit any angle of roof from 50 degrees to flat, and there is no need to stock different angles to conform to various pitches. This means a saving and economy in stock. Simplex flashings are guaranteed to perform every service for which they are made.



Testing For Trouble With Incandescent Lamp In Cut Out Socket

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Power Plant Exhibits

STROLLING through the machinery hall at the Toronto Exhibition, one is struck with the very small representation of firms dealing with power plant equipment, both steam and electrical. Of course, it is admittedly not a hall that lends itself to much of an exhibit, being overcrowded and inconvenient, but when one considers the exhibitions put up at conventions of engineers, the thought is born that at least there should be something worth while. An exhibition like the Canadian National Exhibition attracts practically every representative in the community, and not only operating engines, but owners of factories, superintendents, and what not, are passing round all the time. There is one exhibit, that is a Diesel engine in operation, that will be found of interest to the engineer, but why are there not exhibits of steam engines, steam turbines, various kinds of motors, and all the equipment of a power plant in one central spot, with a distinctive name so that those interested in these lines would know where to go?

The machinery hall while probably designed for those kind of things, in the beginning, is more and more taken up by the manufacturers of machine tools, and general industrial machinery, to the exclusion of all but a few firms specialising in power plant equipment. We believe that if the Exhibition authorities would find space, there would be enough firms to fill a hall devoted to steam and electrical power plant equipment, including prime movers and steam generators. Such an exhibit would attract a very large audience, and among them, a good percentage of prospective customers.

It Will Soon be Winter

THE advent of the Exhibition in Toronto serves the purpose among others of reminding us that the end of the summer is fast approaching, and the time of cooler air approaching. This to the ordinary citizen only conveys a feeling of relief from the discomforts forced upon him during the hot moist months. To the operating engineer, however, it has another meaning, that is that soon he may be called upon to supply heat to various parts of his plant. How he looks upon this prospect will depend largely on how he has availed himself of the warm season's hours to put his heating apparatus in thorough order. If he has gone over it from end to end, overhauling piping, both steam and return, radiator traps, reducing valves, vacuum pumps, etc. until he knows it is ready to function in every particular, he can face the coming cold weather with equanimity. If on the other hand, he is numbered among those who put off everything that shows immediate pressing need, he is in for some uncomfortable times. There are few things more annoying to an engineer, and few things that get him into quicker disrepute, than having factory employees and the superintendent complaining that the rooms are too cold to work in. This is bad enough, but there will be double the amount of howling if the main office, where the manager or proprietor has his august presence, is at a temperature below that necessary for comfort. There is no excuse that will avail when this occurs, and generally there is no excuse for it happening. There is generally enough steam to supply the heating requirements when the engine is running, and it sometimes happens that the engine exhaust is more than necessary, but some parts of the building are cold because of defective radiator traps, leaks in return pipes where there is a vacuum system, or risers filling with a water seal owing to a trap being out of order.

If the necessary repairs have not been made during the summer, there is very little chance of them being made before the spring once the heating system starts, and that means six months of discomfort for the factory employees, and recriminations for the engine room staff. Get your heating plant in order before the cold days come, and then you won't have double reason to dread the advent of a cold snap, but will be able to face the winter with confidence that all will go well.

Saving the Ice

SOME housewives have lately hit on an expedient for saving ice, which consists of wrapping the ice in a blanket or newspaper. There is no doubt that ice protected in this way will last longer than it otherwise would, but it will have a correspondingly smaller effect in keeping the food cool, or cooling it down when first put in the refrigerator. To carry the thing to an extreme point for the sake of illustration, if the ice were perfectly insulated it would last forever, but its cooling effect on the food would be nil. The only way that ice can perform its cooling functions is by absorbing the heat from the surrounding bodies and atmosphere in the refrigerator, and if the refrigerator itself were perfectly insulated, the ice would absorb the heat from the food and air in the frig. until they were at the temperature of the ice, and then everything would remain at that temperature until the doors were opened, admitting warm air. In the ordinary household refrigerator, the insulation is far from perfect, and a certain amount of heat is radiated through the walls of the frig from the outside air, which has to be absorbed by the ice, the result being that sufficient heat units are absorbed to effect the change from ice to water. Insulating the ice decreases its power of absorbing this heat, or rather the rapidity with which it will absorb it, and this means that it takes longer to cool the interior. You cannot absorb the heat from the frig. and keep your ice at the sam time, desirable as that result might be. The enterprising firms who are selling blankets for wrapping ice are trading on the ignorance of the average housewife where science is concerned.

It will soon be winter.

Progress in New Equipment

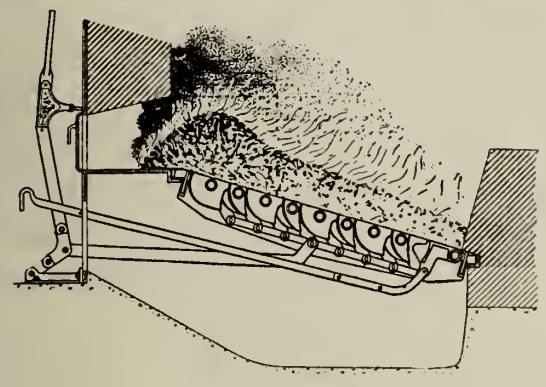


FIG. 1

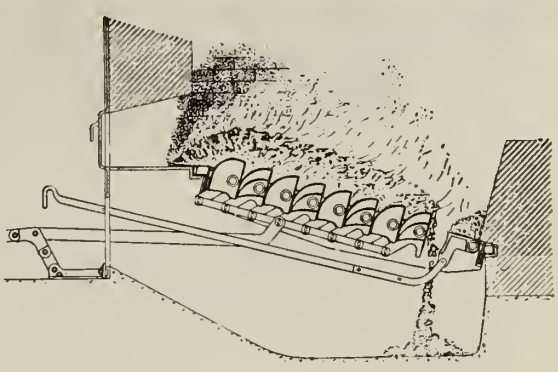


FIG. 3

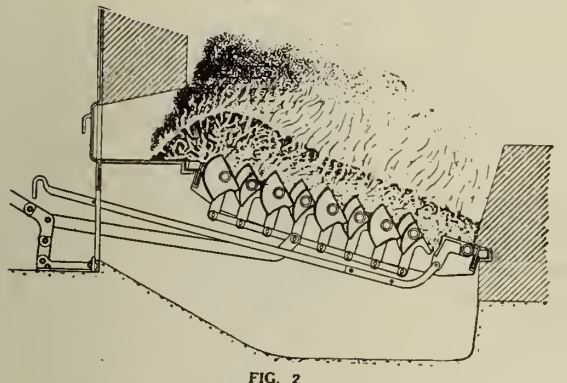


FIG. 2

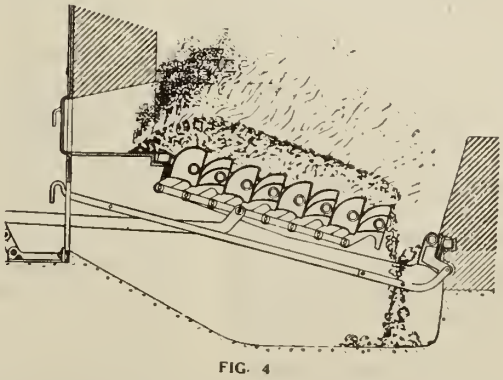


FIG. 4

THE COKAL HAND STOKER

The Cokal Hand Stoker has been designed for those plants where the investment required for mechanical stokers is not justified. The Cokal hand stoker consists of an arrangement of bars adapted to be moved by levers and with several special features tending to added economy. The bars are supported by a trunnion practically in the centre so that the labor required to move them is very slight. Special arrangements are made to govern the loss of coal through the bars, and a varied ash discharge opening can be secured at will.

The range of size is large, from thirty inches square to one hundred square feet grate surface being possible. The following illustrations will give an idea of the operating principles of this stoker.

Figure 1 shows the stoker in the normal working position. The green coal is fired on the front of the stoker and the rear furnace temperature distils the volatile hydro-carbons, driving them over the incandescent coke which auxiliary, while large clinkers easily has been moved along to the rear, thus insuring complete combustion.

Figure 2 shows the stoker in the stoking position. In this position a half throw of the lever distributes the coke evenly over the stoker surface. All holes in the fire are filled, due to the action of the intermeshing bars. An uniform fuel bed is obtained, resulting in even air distribution through the fire.

Figure 3 shows the position when ash is being discharged, with the auxiliary discharge closed. A full throw of the lever operates the dump bar in the rear of the stoker, and the ash refuse is precipitated into the ash pit. For large clinkers the auxiliary is used, as shown in the illustration figure 4.

Figure 4 shows the combination ash and clinker discharge opening. With this combination three different sizes of opening are obtainable to suit the ash residue from the kind of coal used. With ash and small clinker the standard active dump bar is used with auxiliary close as shown in the previous illustration. Medium sized clinkers are discharged by operating the separate drop through by opening both dump bars and auxiliary as shown in figure 4.

THE JENNINGS HYTOR PUMP

The above pump which is manufactured by the Nash Engineering Co., South Norwalk Conn., and sold in Canada by the Arthur S. Litch Co., Toronto, is specially designed for handling returns from a low pressure heating system, and returning them to the boiler. The pump is also a vacuum pump, and it is claimed that owing to its peculiar design, it will maintain a vacuum on a heating system with a much less expenditure of power than the ordinary type of pump.

Description of Pump

The pump consists of two independent turbine units, an air pump and a water pump, combined in one casing, the impeller of each being mounted on the same shaft. One of these impellers continuously exhausts the air and vapor, and discharges it into the atmosphere, while the other impeller handles the condensate as it accumulates and discharges it to either hetwell or boiler. Thus the air and vapor does not have to be discharged against pressure, and the con-

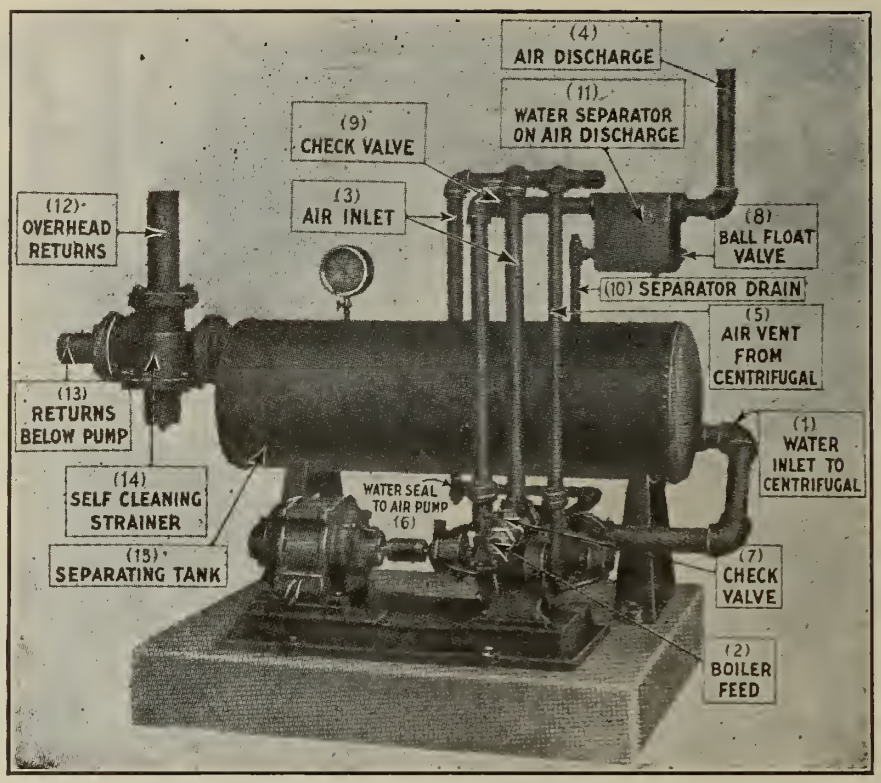
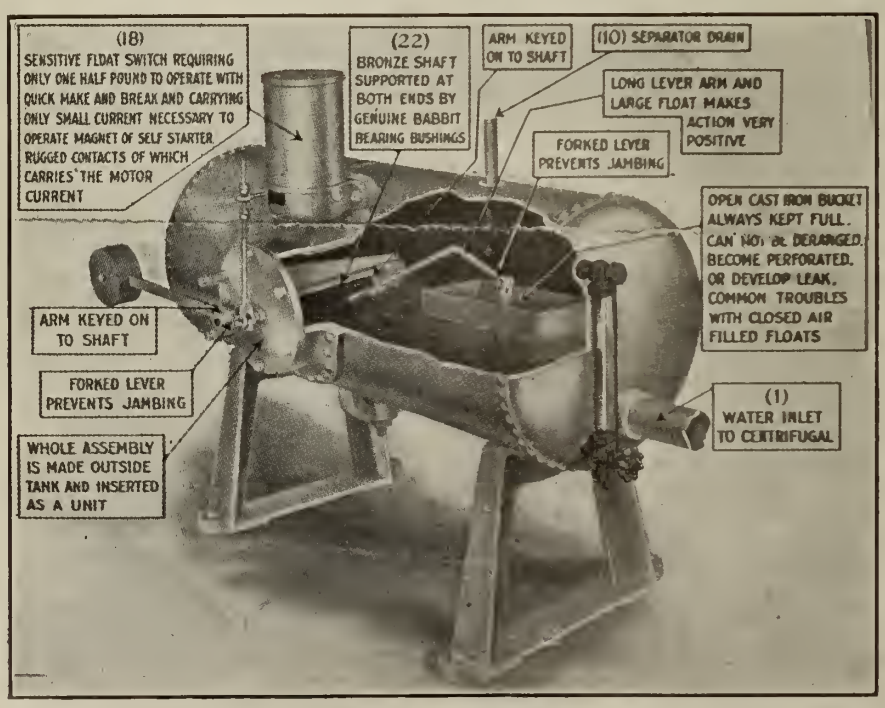


Fig. 3.—General arrangement of pump and receiver.

densate is returned free of air to the boiler.

The air unit consists of a rotor in hydraulic balance, revolving in a casing of elliptical form having large clearances. The water turned with the rotor, and owing to the action of centrifugal force will follow the shape of the casing, thus being forced away from the rotor by centrifugal force where the casing is large, and forced back onto the rotor by by the casing where it is small. When the latter action occurs, the air is compressed and forced out through the outlet ports. When the water is leaving the rotor in the enlarged portion of the casing, the air is drawn from the inlet ports by the vacuum created.

The water remains at the level of the outlet ports, the small amount drawn in with the air from the returns being delivered with the outgoing air, where it is separated and returned automatically to the heating system. The air unit being positive in its action, is capable of exhausting a large volume of air, and


(18)
SENSITIVE FLOAT SWITCH REQUIRING ONLY ONE HALF POUND TO OPERATE WITH QUICK MAKE AND BREAK AND CARRYING ONLY SMALL CURRENT NECESSARY TO OPERATE MAGNET OF SELF STARTER. RUGGED CONTACTS OF WHICH CARRIES THE MOTOR CURRENT
(22)
BRONZE SHAFT SUPPORTED AT BOTH ENDS BY GENUINE BABBIT BEARING BUSHINGS
ARM KEYED ON TO SHAFT
(10) SEPARATOR DRAIN
LONG LEVER ARM AND LARGE FLOAT MAKES ACTION VERY POSITIVE
FORKED LEVER PREVENTS JAMBING
OPEN CAST IRON BUCKET ALWAYS KEPT FULL. CAN NOT BE DERANGED, BECOME PERFORATED, OR DEVELOP LEAK. COMMON TROUBLES WITH CLOSED AIR FILLED FLOATS
ARM KEYED ON TO SHAFT
FORKED LEVER PREVENTS JAMBING
(1)
WATER INLET TO CENTRIFUGAL
WHOLE ASSEMBLY IS MADE OUTSIDE TANK AND INSERTED AS A UNIT

Bucket Float Mechanism.

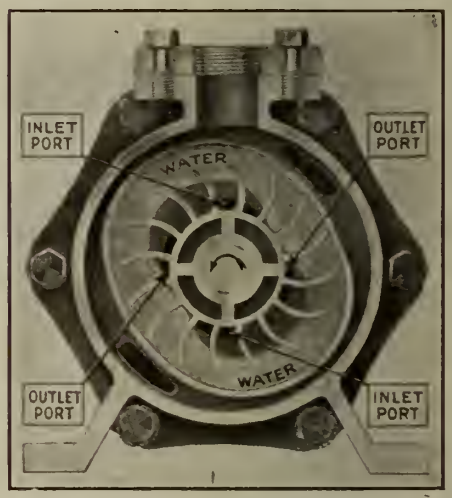
with freedom from any pulsation, as can be readily understood if the construction is examined.

The Water End

The water unit is a centrifugal pump specially designed to give high efficiency on either hot or cold water, and to unload when not handling water. The power required is closely proportional to the quantity of water pumped. The impeller is bronze, with renewable sealing rings.

The Operation

The operation of the pump is as follows. Referring to Fig. 3, the heating returns air and water, pass through the self cleaning strainer, (14) into the separating tank (15). The water falls to the bottom of the tank and passes into the centrifugal through the pipe 1, driving out the air through the pipe 5. As soon as the centrifugal is full of water it begins to pump and forces the condensation into the boiler through the pipe 2 emptying the tank. The centrifugal now stops pumping, being unable to handle air, and the check valve 7 prevents a back flow. The power required to drive the centrifugal is closely proportional to the quantity of water handled. It takes



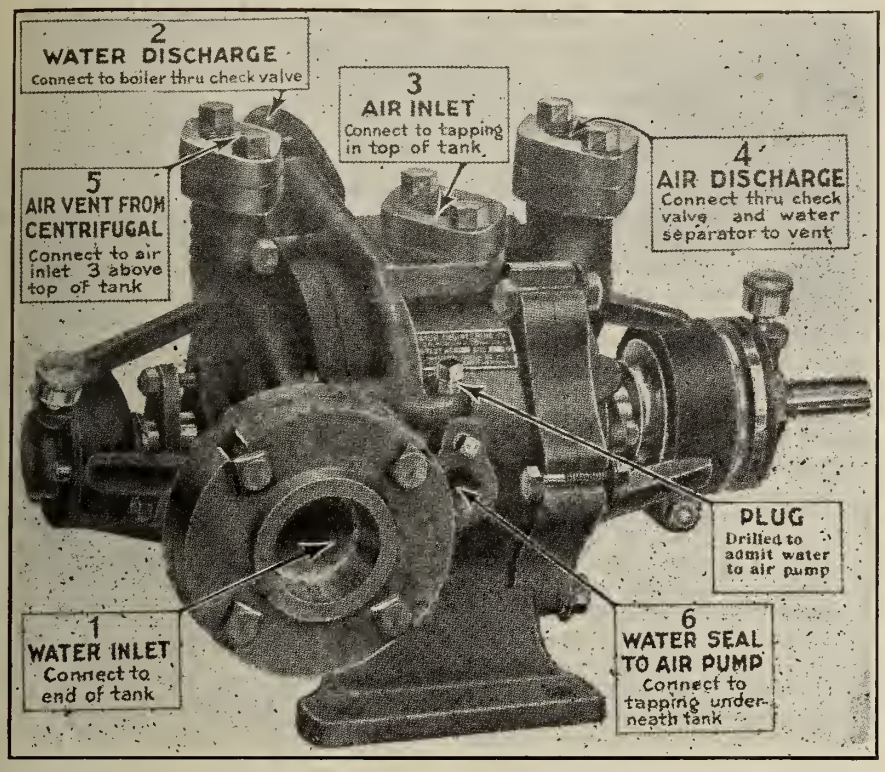
Construction of air pump.

almost no power when it is not pumping. The air is rapidly exhausted from the system by the air unit which is connected to the top of the tank by the pipe 3.

The small amount of water necessary to keep the air end primed is obtained from the bottom of the separating tank 15 by means of the pipe 6. The water is discharged with the air and is thrown to the bottom of the separator 11, and automatically returned to the tank 15, through the pipe 10, the ball float valve 8, preventing any air from re-entering the system.

Cut No. 4 shows the details of the bucket float mechanism.

The bucket is kept filled with water by the returns from their separator. When the bucket is submerged by water rising in the tank, the weighted arm outside the tank is heavier and falls, closing the switch and starting the pump. When the bucket is unsubmerged by the receding water, the weighted arm out-



Outside view of pump.

side the tank is overbalanced and rises, opening the switch.

The float is made of cast iron kept alwaysfull of water. It is therefore, not subject to derangement due to leakage—a common trouble with closed floats.

The float mechanism is exceptionally well made. The bronze shaft carrying the float and counterbalance arms is supported on each end by tin bushed bearings mounted in a cast iron bracket cast integral with a flange bolted to the tank.

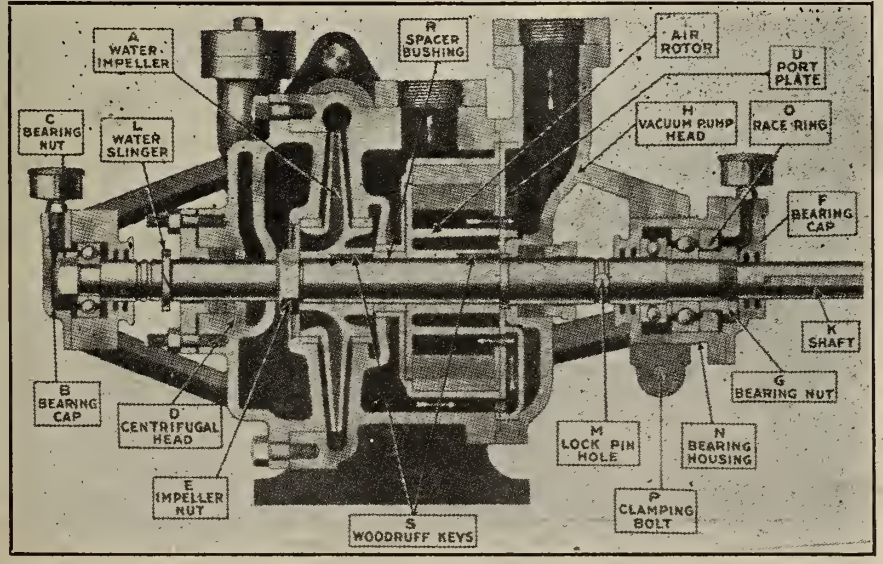
By removing the bolts in this flange, the whole float mechanism may be removed from the tank as a unit. The lever arms are keyed to shaft. Forged forked connections are supplied to the connecting lever.

DESCRIPTION OF SUPERHEATER

Perhaps the best definition of a superheater is that it is an apparatus of an accessory nature, placed in a boiler to heat the steam, just previous to its discharge from the boiler, to a temperature higher than the definite temperature for the pressure, in order to avoid condensation difficulties, as this extra heat must be given up before any condensation occurs. Everyone familiar with steam knows that in its ordinary condition as generated in a boiler it has a definite temperature for every pressure. Ordinarily if heat is added to steam its pressure increases. If heat is taken away its pressure is reduced and a certain amount of condensation takes place. The steam, as generated in the ordinary boiler is known as saturated steam. Superheating the steam is accomplished by leading the steam off from the water, from which it is being generated, through the drier pipe to a superheater from the header, known as the saturated series header, usually placed in the smoke box, the steam is circulated through a series of coils placed in the flues of the boiler so that the gases of combustion, which are of a higher temperature than the steam, can impart still more heat to this steam. Sometimes it is necessary to alter slightly the flues or water tubes of a boiler. One might readily ask why the pressure does not increase. It does slightly but it is practically all equalized by the fact that there is no check valve between the superheater coils and the boiler proper. After the steam has circulated through these coils it is collected in the superheated series header from which it passes directly to the steam pipe connected with the engine, or turbine where the steam is used.

Saturated steam at 200lb. boiler pressure has a temperature of 388 degrees F. If this steam after passing through a set of superheater coils had a temperature of 488 degrees F. we would This heat must be given up before any say it had 100 degrees of superheat. condensation occurs. Superheater headers are made from cast iron or cast steel while the tubes now used in the high temperatures prevailing in most installations, are of steel. Some firms use a special form of seamless tubing with a forged return elbow all of which is in one integral piece. Superheater tubes are larger in diameter than the flues or the tubes. There are many interesting constructional details in these installations.

The capacity of a superheater is usually slightly in excess of the maximum boiler capacity.



Sectional view of pump.

Slow, But Not Sure.

"Do you drink coffee?" asked the doctor of an aged patient.

"Yes," was the reply.

"Coffee," continued the M.D., "is slow poison."

"Yes, very slow," replied the old man; "I have taken it daily for nearly eighty year."

SMOOTH-ON INSTRUCTION BOOK. No. 18

A pocket booklet, 4-inch by 6-inch and containing 144 pages of useful information and instruction on the uses of Smooth-On, has been issued by the Smooth-On Mfg. Co., Jersey City, N.J. Smooth-On is put up in 7 different forms for various purposes and the makers also manufacture an iron concrete paint and a Smooth-On coated corrugated iron gasket.

The book is profusely illustrated showing actual repairs done by Smooth-On in mending leaks and breaks in machinery, castings and a wide variety of articles.

Production Welding of Varied Steel Products

The Reactions—The Operation—Depth of Fuel Feed—Mechanical Producers—Capacity of Producers—Producer Fuels—Slagging Producers

THE essential features in the efficient and economic working of a producer can be enumerated as follows: (1) Even distribution of coal; (2) uniform and continuous production of good-quality gas; (3) a regulation of depth of fuel bed to obtain as complete as possible of CO to CO_2, and also the decomposition of the steam; (4) removal of ashes and clinker in as simple a manner as possible; (5) low cost of operating and installation with quick and efficient gasification.

The first important development that occurred was the method of increasing the speed of gasification. The rate of combustion obtained in the Siemens producer was very slow, which gave the idea to others that, seeing the regulation of the air was only by chimney draught, the application of a forced draught of air would accelerate this. The results expected were attained, but the heat was naturally intensified, which resulted in the formation of much clinker. This trouble was not felt in the original low-capacity Siemens type on account of the fact that the large area of grate bars allowed sufficient heat radiation to keep the temperature down below the melting point of the ash, which is the real factor to be dealt with in considering the clinkering qualities or tendencies of any fuel.

This question of clinker thus necessitated the devising of some method for the reduction of temperature in the producer, and the method adopted was the introduction of a jet of steam for blowing the air, thus giving the necessary vapour for temperature reduction. It was then discovered that the increased pressure in the producer due to the forced draught cause an extensive leakage of gas through the bottom, which resulted in the general adoption of the water seal which also allowed the easy removal of the ash without affecting the continuous operating of the producer.

To work in conjunction with the forced-draught producer various types of grates and tuyeres were designed, but the most effective has been found to be the conical mushroom-shaped tuyere of two or three domes, which gives a most uniform distribution of the blast to all parts of the producer.

Reactions

In tracing the reactions which occur in the producer it is best to start with the air alone. As it leaves the tuyeres the air passes through the ash bed, until it comes into contact with the fuel, at which point the fuel actually burns, completing combustion thereby, and forming CO_2, with the evolution of a large amount of heat. This heat is utilised to heat the fuel above to the incandescent state, and by passing through the incandescent mass of fuel the CO_2 is reduced to CO. The first portion or zone when the fuel is burned is called the combustion zone; the second zone, where the thick bed of incandescent coke is found, is the decomposition zone, a third zone, above the decomposition zone, is called the distallation zone, and consists of a layer of fresh fuel, fed in at the top of the producer. In the distallation zone we find, as the name implies, a distilling of the coal or a driving off of the volatile matter in the fuel, with the formation of tarry vapours containing the higher hydrocarbons, such as methane, ethylene, and other gases in the higher series. From a producer using air alone we would then obtain a mixture of gases containing CO as the chief combustible, methane and ethylene, with the other tarry vapours in small amounts, and in addition nitrogen from the air and a little CO_2 which passed through the decomposition zone unreduced.

As regards the reactions occurring on account of introducing steam with the air, in passing through the hot zone the steam is heated to a high temperature and decomposed into its constituent elements, hydrogen and oxygen. This is an endothermic reaction, and absorbs a large amount of heat. Thus, the temperature of the combustion zone is kept below the melting point of the ash, the temperature varying inversely as the amount of steam decomposed. By regulating the amount of steam introduced we can therefore regulate the temperature at which the combustion zone is working, which, by being kept slightly below the fusing point of the ash, will effectively prevent the formation of clinker. The hydrogen formed by decomposing the steam passes unchanged through the producer and mixes with the other gases, raising the percentage of combustibles, and, of course, diluting the nitrogen content. The oxygen formed in decomposition of the steam combines with more carbon, with the ultimate formation of more CO, which again brings up the percentage of combustibles.

From the results of much research on the correct temperature at which to work the combustion zone it has been fund that to operate a producer most efficiently the temperature of the combustion zone should never go below 1.125 degrees C. However, many coals form ash which fuses below this temperature, and in order to use this inferior coal the producer must be worked less efficiently and at a lower temperature than that given, in order to prevent the undesirable formation of clinker. This is a point which has been overlooked in almost all works or books on producer gas, but in practice it is found quite frequently, especially at the present time during the scarcity of coal, when through necessity poor grades are used.

Operation

The usual defect in producer operation, particularly of the hand-fed and operated type, is the fact that the coal is not fed in at sufficiently regular and frequent intervals, the result being that the furnaces are submitted to a regular cycle of excess gas, gradually diminishing to a correct mixture of gas and air, and thence eventually to a shortage of gas and excess of air above that required for complete combustion. It is within the author's knowledge that in tests conducted on gas-fired furnaces with hand-fed producers the chimney-gas analyses have ranged from 12 per cent. $CO.^2$, 4 per cent CO, and three per cent. O, at the time of firing the producer, down to 5 per cent. $CO._2$ and 14 per cent. O when the charge of coal was spent, and just previous to the next charge. The effect of this intermittent firing at long intervals on the furnace itself is that the furnace is flooded with gas to begin with, the temperature being lowered, and volumes of gas and smoke pour from the furnace doors and other openings.

The direct fuel waste under these conditions is very seious, and yet many old-school furnace-men are never satisfied unless this waste exists, the general impression being that they then know the furnace is full of hot gases. This of course, emphasises the need for systematic elementary instruction of furnace hands in the principles of combustion and fuel economy. Some reflection thus makes it clear that by feeding the producer by hand in this way ,only for a few moments during the cycle of conditions of gas supply is the plant working at its maximum efficiency, the chimney loss at the remainder of the period being anything up to 45 per cent of the heat value of the fuel used. It should, however, be stated that often these wasteful conditions are seriously accelerated by the regulation of the gas and air supply, careful regulation by the furnacemen being conspicuous by its absence.

Another frequent and serious fault discovered in hand-operated producers is the neglect displayed on the part of the average gas man to rectify channelling; that is to say, passages develop from the tuyeres to the fuel bed permitting free air to pass through and dilute the gas above the fuel bed as well as burning it to $CO._2$ and wastefully raising it in temperature. This is not the only result, for the channels provide an easy access for the blast;

consequently, less air passes through the fuel bed, and less combustible is generated, another bad feature being the clinkering which occurs due to the burning of the air and gas in the aforementioned channels.

It is easy to understand the gas man's aversion to poking, for nothing less than a 12ft. by 7-8 in. diameter poker is of any use. Maintaining the fuel bed in good condition entails its very frequent use, and the work is certainly laborious. The result is that little or no solidification of the fuel bed is attempted, and consequently numerous air channels are formed, which very often means that the temperature above the fuel bed rises to such an extent that the hopper bell is melted. Under such conditions the percentage of $Co._2$ is naturally very high. The only solution of the difficulty is the general adoption of mechanically fed and mechanically poked producers.

Another fault frequently met with is due to the want of systematic procedure in cleaning, particularly water-sealed producers. Frequently only the first 2ft. or so of the ashes are removed from the water seal, leaving the central portion undisturbed. Consequently, when dropping the fire the centre will not fall due to there being no space to receive it. Thus, the residue towards the centre sets like cement, requiring the application of sledge hammers for removal, and also in such cases the gas is poor due to the uneven state of the fuel and ash bed and the difficulty of preventing channelling. It should therefore be impressed on the gas man that each producer should be systematically cleaned right to the tuyere, as a clean producer works and makes good gas under normal conditions. To guarantee this cleaning, various mechanical devices are now in successful operation for performing this work.

Depth of Fuel Bed

In considering what the depth of fuel beds should be for a producer, points which must be taken into consideration are: (1) Nature of fuel as regards coking; (2) nature of fuel as regards melting point of ash; (3) nature of fuel as regards size; (4) type of blower; (5, rate of gasification; (6) method of agitation of fuel bed, either hand-poked or mechanically operated; (7) method of removing ashes.

For ideal conditions one would have a very thick fuel bed having about the following proportion: 18in. to 30in. of incandescent zone, and about 9 in. of fresh fuel as distillation zone. To obtain a bed of this dimension it would be necessary to have a non-caking or coking coal, with an ash which is of a very high melting point, and the fuel should be screened nuts. The blower should be one of ample capacity to furnish a large amount of air with a small amount of steam, as the thickness of the bed depends wholly on the amount of air which can be used to give a very high temperature at the bottom of the incandescent zone, where the intensified heat is carried upwards and used to heat up the incoming coal. The amount of heat made, of course, will determine the amount of thickness of the incandescent zone, as it heats up the incoming coal, driving off the volatile matter and later heating the coke to incandescence. If the ashes from the coal are of a low fusible nature this high temperature cannot be carried, as the ashes will fuse and clinker will result. The advantage of a thick incandescent zone is obvious. The longer time which the $Co._2$ has to be in contact with incandescent coke, the more it will be reduced to CO, thus reducing the incombustible gases to a minimum and utiliing the full carbon content of the fuel in the formation of combustible gases. The fuel must be of non-coking variety in order that the ditillation zone does not become a sticky mass, which would prevent the air from being blown through the producer, and would cut down the rate of gasification, thus, of course, lowering the depth of the incandescent zone. The distillation zone should be of such thickness that the temperature of the gases leaving the producer is about 1200 degrees F to work a producer in a very efficient manner. The heat then being kept inside the producer by the incoming coal, it is neither lost by radiation from the flues, nor is it wasted by being sent to the stack as in the case of regenerative furnaces, but it is used instead to drive off the volatile matter from the fuel.

Another advantage of a thick fuel bed is that it tends to give a very uniform gas in composition, the thickness of the bed being such that any slight variation in the amount of steam or air does not have any very great effect. Furthermore, since the top temperature gets considerably lower than in the average practice, a sudden dump of coal upon the bed will not give a sudden rush of the gases to the furnace and up the stack. It is seen that with a thick fuel bed and a low-temperature gas being involved, the volatile matter is driven off slowly and continuously over a thick amount of fuel, and the average value of the higher hydrocarbons is spread throughout the time between dumps. With a fuel which clinkers very easily due to its low melting ash, it is, of course, necessary to use more steam in the blast. This necessitates a thinner decomposition zone, and also a thinner distillation zone, but it is always best to work any producer and any fuel with as thick a bed as is possible under the existing conditions. It has been discovered after careful investigation that at least 90 percent of producers will be found to be carrying too thin a fuel bed, this being invariably due to the bad method of operation into which the gas man has fallen.

Mechanical Producers

During the last few years various attempts have been made to evolve a mechanical producer for the removal of the troubles previously referred to as being part of the hand-operated type. It therefore develops into producing a machine that gives: (1) An automatic method of feeding the fuel uniformly over the entire bed and in small amounts at a time; (2) a method of agitating the fire bed for the retention of a level surface, and the prevention of the formation of holes or mounds; (3) the automatic removal of the ash.

This question of mechanical producers has had particular attention in the United States, and various machines have been designed and are at present in successful operation, each of which has certain features which are of great interest, and the results obtained have been highly satisfactory. During the last eighteen months the author has been directly interested in the installation, testing, and working of the Chapman floating agitator with automatic feed. The general idea in connection with producers has been to design a producer that rotates—i.e., the whole of the producer casing, fire-brick lining, and bed,—the agitation being performed by either stationary pokers or swinging scrapers. The Chapman Engineering Company, however, diverted from this, as they concluded the correct method of agitation was to rotate the portion that did the work, thus removing the heavy work entailed in rotating the producer itself. The author then described the Chapman producer.

Capacity of Producers

This depends not only on the special type of producer, but also upon the quality of fuel used. The possibility of the ash in any coal determines its maximum rate of combustion on any producer. With a very fusible ash the rate of combustion must be reduced to make good gas continuously without excessive labour or much waste. With good-quality and low-ash coal, high in volatile, more may be gasified per square foot of grate area than with those less-marked "gas coals." Where fuels have an increase of ash or sulphur, or by a considerable amount of fine coal, the rate of gasification decreases, in many cases this not exceeding 6lb. per sq. ft. A deeper fuel bed is required for bituminous coal than for anthracite, the quantity gasified naturally varying with the quality. With an up-to-date mechanically operated producer 40lb. per sq. ft. area is often obtained, the gas being of excellent quality, and the figure of 25 lb. per ft. can be taken as a fair average.

Producer Fuels

Ignoring such substances as peat, wood, sawdust, etc., each of which is being continuously used for the production of gas, we find that anthracite, bituminous, and semi-bituminous coals are the ones usually employed, though lignite and brown coals are also now being utilised, the fixed carbon being the basis of producer action and gas yield. Coke is also employed, and particular mention of this is made in the section of the paper referring to slagging producers.

The fuel of the highest heating power is the best, for the use of lower grades means higher initial outlay in the plant

(due to the low gasification), more labor charges, greater loss of combustion in the ash, and greater difficulty in operating. In high-temperature work a high percentage of volatile hydrocarbons in the coal is desirable, a smaller percentage of coal being necessary. Lower-volatile semi-bituminous coals, say 20% volatile, work satisfactory. Strongly caking coals are objectionable, but freer-burning coking coals give good results.

The fuel should be graded to as nearly a uniform size as possible, thus assisting in handling and feeding the producer, nuts being excellent, while in the event of lump coal being supplied this should be broken through a 3-in screen.

Fine dusty fuels should be avoided, the result of using these being the formation of a compact bed, requiring a higher pressure of blast to penetrate, and thus carrying over dust which develops into a nuisance in congesting the flues, furnace regenerators, etc. Any portion of the bed that happens to be loose allows easy penetration, burning the gas and lowering the efficiency, or, again, if the resistance of the bed is too great the blast seeks the walls as place of least resistance, the gas becoming high in carbonic acid, with the result that the gas is worthless. Sulphur should be as low as possible, as when present as iron pyrites it fuses readily and forms very troublesome clinkers.

The amount of steam required varies with the quality of the coal gasified, especially with the melting point of the ash. Coal having a low melting ash takes about 0.42lb. of steam per pound of coal gasified. Coal with high-melting ash takes about 0.3lb. It can be generally taken as 0.35lb. of steam per pound of coal. One ton of coal per hour then needs 784lb. of steam or water evaporated per hour. The pressure required varies; with the primary nozzle in the blower using a ½in. nozle, about 54lb. pressure per sq. in. is recent experiments conducted in Ger- Using a 9-16-in nozzle, steam pressure for the same amount would be 47lb.

The temperature of the blast, (steam and air mixture) indicates the proportions of air and steam. Poor coal of low-melting ash needs high-blast temperature, hence more steam per ton of coal. "Back pressure" is the pressure in blast due to resistance of ashes in the coal, plus gas main pressure, and is generally about 3½in. water gauge The Champian blower works against 7-in. efficiently. The usual limits of blowers are 4-in. or 5-in.

Slagging Producers.

The question of slagging producers has not been considered to any extent in this country, but it is claimed from recent experements conducted in Germany and elsewhere on the Continent that excellent results are being obtained. The fuel used is coke, to which iron furnace slag is added as flux.

Recent successful experiments with this type of producer have been conducted at the works of the Georges-Marienhutte at Osnabruck. The gas obtained is remarkably dry, due to the fact that the blast is supplied by air only, no steam being admitted. This high heat value is due to the high percentage of CO, which approaches 50% whereas the percentage of CO_2 is low.

It is claimed as the main advantage of this type that flues with as high as 50% ash can be gasified. Naturally the fluxes have to be varied in quantity and description to suit the variable ash content. Low grade iron ores are used to advantage, which otherwise are no use for reduction. The cost of operating the producer is reduced by selling the pig iron thus obtained as a by-product, but the author is very doubtful of the success obtained in these sales.

At a certain German steel plant these producers were tried without the addition of iron, but it was discovered that the operation only worked satisfactorily for a short period; the slag became more viscous, and finally solidified, thus causing the producer to be stopped. Various methods were tried to prevent this. The first conclusions arrived at were that due to the slag getting in contact with the cold bottom of the producer a chilling effect occurred, and to alter this a separate chamber was built under the producer, but this unfortunately only lengthened the trouble without eliminating it. It was after this that a flux in the shape of pig iron ore was charged in with the fuel, after which no further trouble was met with in keeping the slag in a sufficiently molten state for tapping off.

One of the main difficulties, however, has been the problem of applying a producer of the type for the gasification of fines, the necessity for using air blown at comparatively high pressure causing fine particles to be blown out in suspension with the gas. This naturally caused trouble by filling up the generating chambers at the furnaces with dust, but although the area of the flue bed was considerably enlarged, thus reducing the velocity of the gas, the trouble could not be entirely eliminated by this method. However, a design has recently been developed, in which dust catchers are arranged at the top sides of the producer. As the velocity of the gas in these chambers is reduced, the particles deposit, and gravitate through pipes containing gates into the tuyeres, and are again blown into the producer.

The question of the application and design of this slagging type of producer is receiving a certain amount of attention in this country, but it is still in an experimental stage, while the question of slag always makes a troublesome proposition which, if possible, should be avoided, so many conditions occurring that may cause freezing. The question, however, is of great interest and it is possible at some later date that certain combinations in conjunction with producers of this kind will make vastly altered conditions possible in connection with gas production for commercial purpose.

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Strong Steam Traps
Save Every Ounce of Steam

Strong Steam Traps automatically remove the condensation from the systems or machines to which they are connected.

The service rendered by Strong Steam Traps in respect to increased machine output at lesser cost, has resulted in the standardization of Strong Traps by a great many of the largest steam trap users in the world.

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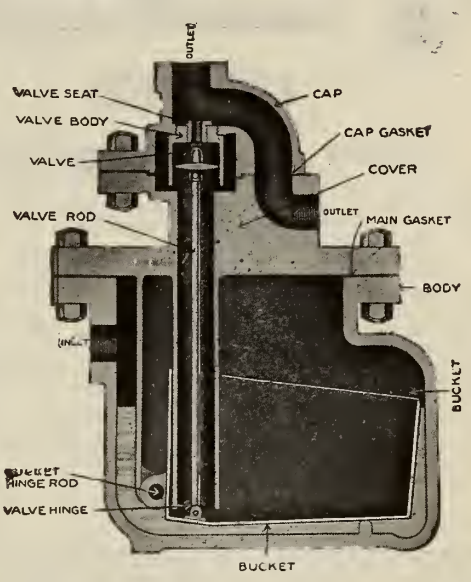

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THERE can be no doubt that they employ the most experienced designers and expert engineering talent to build and operate their plants.

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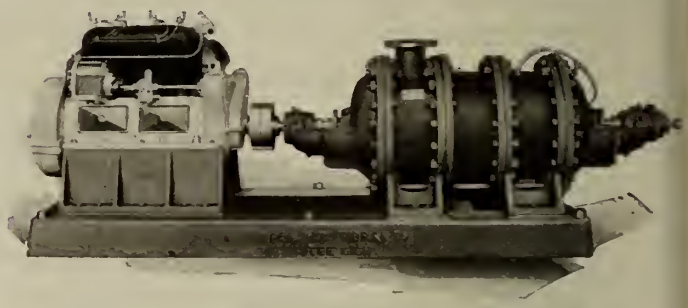

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The prudent manufacturer of machine tools, power plant equipment, or industrial supplies of any kind places his name and the name of his products where they will be seen and remembered to best advantage: **in reliable technical newspapers.**

Reliable technical newspapers in Canada are those included as members of Canadian National Newspapers and Periodicals Association. Their circulation is bona-fide and their editorial practice is carefully guarded, in fact their whole policy must conform to the highest standards else they would not be eligible to membership in the association.

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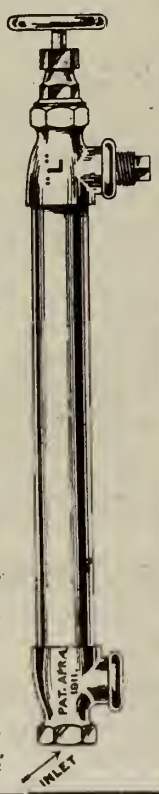
Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt



The Long Patent Steam Trap

Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admissions of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds.

Being open at etarting, it cannot become air bound, this doing away with air cocks or vents — Does Not Freeze.

It is capable of draining from 900 to 1,500 feet of one inch pipe.

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CYLINDER OIL
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E. H. KELLOGG & CO.
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Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

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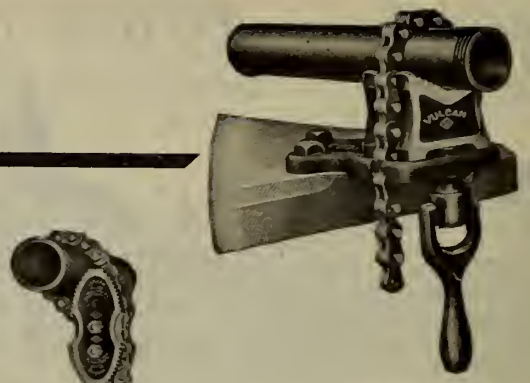

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You can't buy better pipe tools than Williams' "Vulcan" Drop-Forged Chain Pipe Wrenches and Vises.
Wrenches 8 sizes for ⅛ to 18in. pipe.
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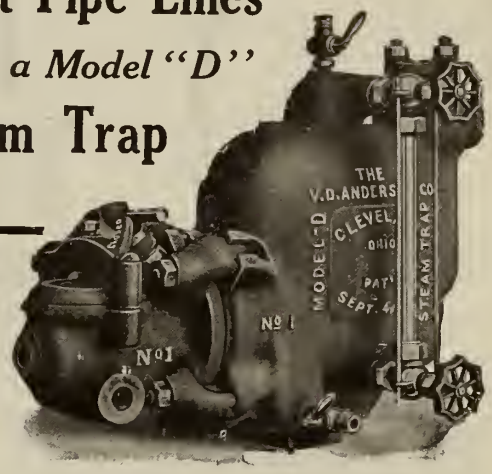

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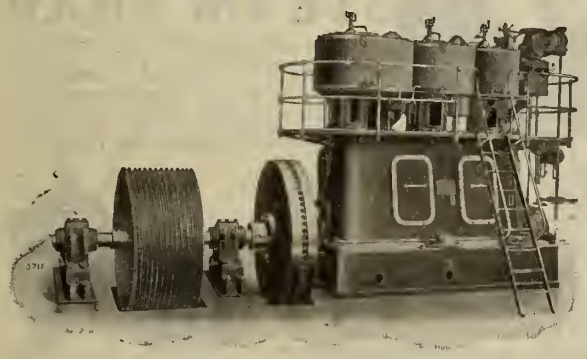

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Cannot get out of order. Compact design.

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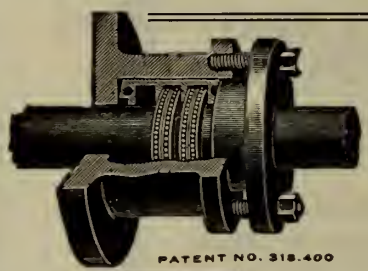

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Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

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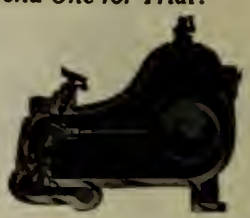

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Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
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Jones "A-C" Stokers

minimize coal cost

Jones "A-C" Stokers cut coal costs in two ways—by burning less coal, and by burning cheaper coal. The full value of the Jones under-feed principle is realized by: automatic control of fuel and air, large capacity retorts, absence of clinker on side and bridge walls, mechanical (not gravity) feed, and "automatic-cleaning."

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Capacity is a prime requisite of high-duty stoking. Jones "A-C" retorts hold a big fuel reserve for quick pick-up. Elimination of ignition arches permits hard driving. Individual control of retorts provides for emergency load conditions. Automatic air and fuel regulation insures high efficiency while carrying heavy overloads.

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The simplicity of the Jones "A-C", and the automatic regulation, minimizes operating labor. "Automatic-cleaning" reduces working of fires. The rugged simplicity cuts repairs and the labor necessary for making repairs. The simple balanced dump plate eliminates high-maintenance complications. There are no working parts in the fire. This also minimizes repairs.

And every Jones Installation proves it!

Many engineers argue that a stoker may be a "howling" success in one plant and an utter failure in another.

This is undoubtedly true. How, then, can you determine just what bearing tests results, made in another plant, have on your own plant? First consider a few typical reports from plants equipped with Jones "A-C" Stokers:

A big hotel at Saint Andrews-by-the-Sea cites a Co Recorder chart showing remarkable combustion efficiency A Canadian paper mill calls attention to big economy burning paper mill refuse ("hog fuel"). Another plant sends a flow meter chart showing 297% of boiler rating for four hours. Other plants report five months of continuous overloads up to 250% of rating.

But these records would not be so significant if it were not for one important fact; the plant that stresscs high efficiency can carry the heavy overloads boasted by the plant that reported them. The plant that is meeting heavy peaks can rival the record of the plant that reports high efficiency. Any of these plants can burn as low grade fuel as any other Jones equipped plant. Why? Simply because the reasons for good performance are the same in each case——because the **design** and **construction** of Jones Stokers is basically **correct.**

So Jones performance records show what can be realized from any Jones Stoker in **any** plant—which includes **your** plant.

Know the basic features behind the unmatched performance of Jones "A-C" Stokers. The new book: "Ten Points of Jones Superiority" goes into detail. Write for your copy.

In this plant nine 823 H. P. boilers are equipped with "A-C" Stokers of 8 retorts each. Originally 7 boilers were equipped; later stokers for two more boilers were ordered.

Canadians and sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized as the Under-Feed Stoker Co., of Canada, Ltd., and the reorganization makes available for Canadian Power users the extensive engineering resources of the Under-Feed Stoker Co. of America.

The Under-Feed Stoker Co. of Canada Limited

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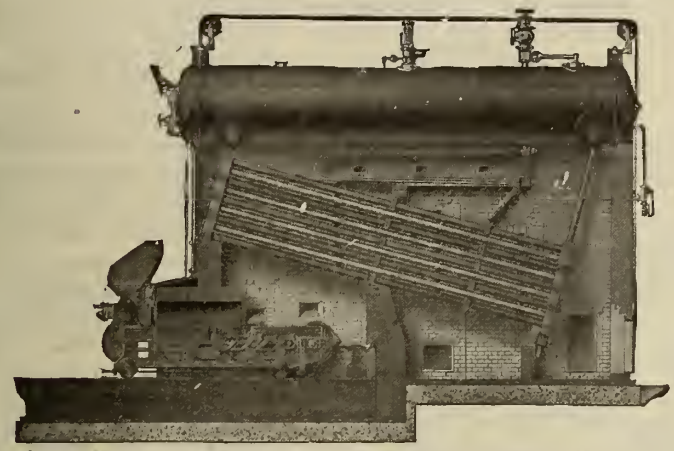

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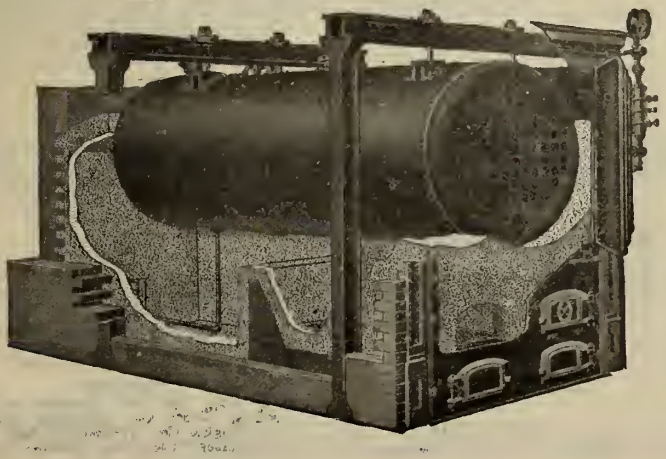

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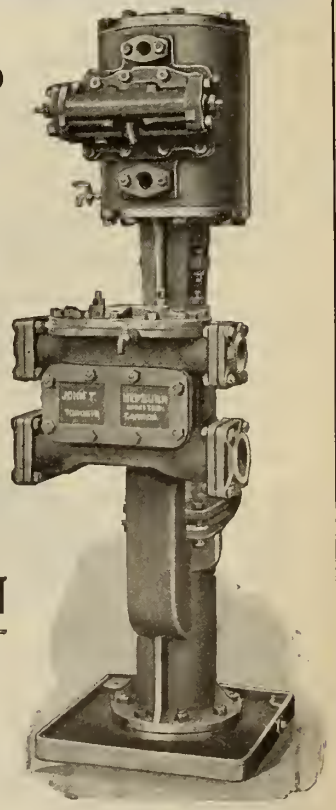

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MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que
Leonard & Sons, Ltd., E., London. Ont

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Beveridge Supply Co., Montreal.
Shell Bat Boico Supply, Ltd., Toronto.
Philip Gies Foundry, Kitchener, Ont.
W. R. Sexton Co., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK, PLASTIC
Beveridge Supply Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Page-Hersey Tubes, Ltd., Toronto, Ont.

How are you treating your fire-brick?

—*their life depends upon it*

WHEN flame and heat get directly in between your fire-brick, the brick can't last as long as when only one surface of each brick is exposed.

When you use fire-clay or cements that melt, crumble or disintegrate, the bond between the brick gives way and falls out. You haven't treated your fire-brick as you should, and you don't get maximum service from them.

Johns-Manville Refractory Cement, when used as recommended, makes a strong bond between the brick that doesn't melt, crack or fall out. And Johns-Manville Refractory Cement applied also to the surface of the fire-brick makes a good brick better.

Write the nearest branch for information about Johns-Manville Refractory Cements numbers 26, 31 and 32.

For extremely high temperatures—above 3200°F—ask about Johns-Manville Super-Refractories.

CANADIAN
JOHNS-MANVILLE
CO., LIMITED

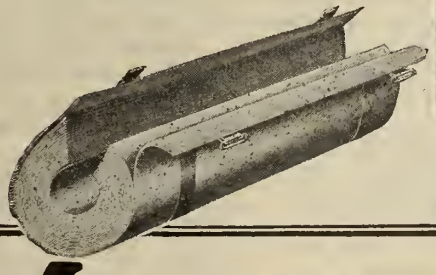
Toronto, Montreal, Winnipeg,
Vancouver, Hamilton,
Ottawa, Windsor

Read how vitally this cement affects the life of your fire-brick.

Saving invisible waste

The heat lost thru bare or improperly insulated pipes frequently escapes unnoticed, because this waste is not visible.

The remedy is Johns-Manville Asbesto-Sponge Felted, the most efficient commercial insulation known—and the most durable because it is a felted, rather than a molded material. It will withstand rough handling and hard abuse. It maintains its efficiency longer than any other commercial insulation, and in many cases outlasts the steam pipe it covers.



JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE

POWER PLANT MATERIALS

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Filley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Beldam Asbestos (Canada) Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Dominion Flow Meter Co., Toronto.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
John Moncrieff, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd Montreal
Gelinas & Pennock, Reg'd, Montreal.
Philip Gies Foundry, Kitchener, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co Windsor Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon-

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

METERS
The Bailey Meter Co., Cleveland.
Dominion Flow Meter Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

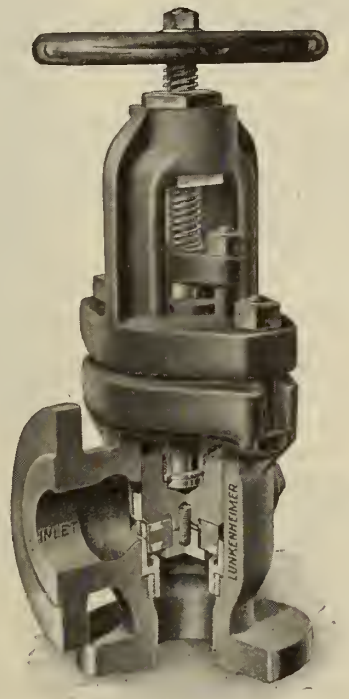
OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Superheater Co., Ltd., The, Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

LUNKENHEIMER
"Duro" Blow-off Valves



"DURO" Blow-off Valves effectively meet the requirements of Boiler blow-off service.

The "DURO" *self-cleansing seat* insures tightness; reduces to a minimum the wear on the seating faces, prolongs their life, and prevents leakage which would impair the economical operation of the boiler plant.

The "DURO" disc is reversible, being provided with two seating faces, and the disc, together with all other parts are renewable. These advantages peculiar to "DURO" Blow-off Valves are the result of years of experience, which, combined with high quality materials and the LUNKENHEIMER method of manufacture, make them valves of unexcelled merit.

The LUNKENHEIMER Distributor in your locality can supply your valve needs. Acquaint him with the operating conditions of your plant. This knowledge will enable him to anticipate your requirements, preventing delay and possible shut-down when an emergency arises.

EQUIP WITH "DURO" BLOW-OFF VALVES.

THE LUNKENHEIMER CO.
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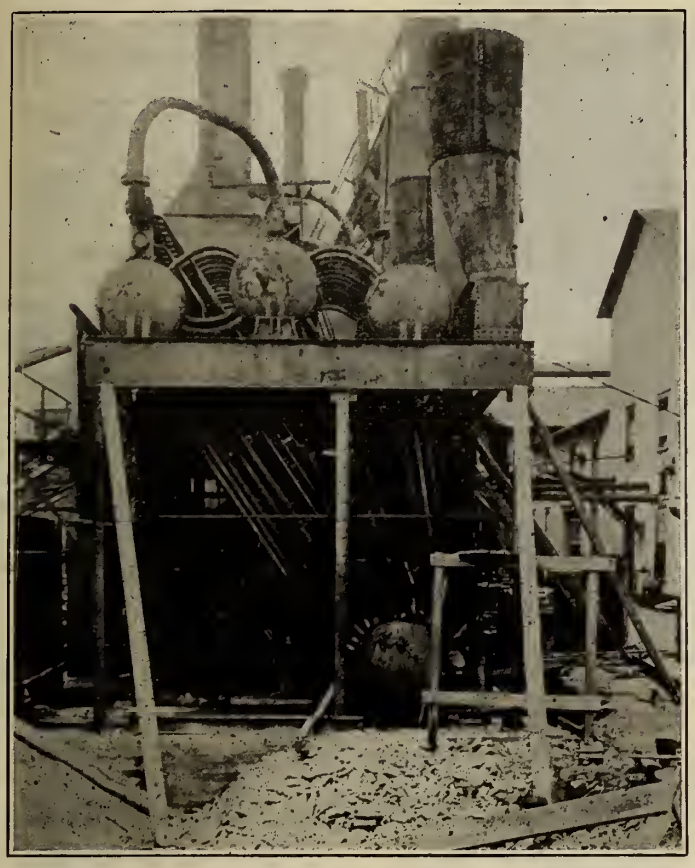

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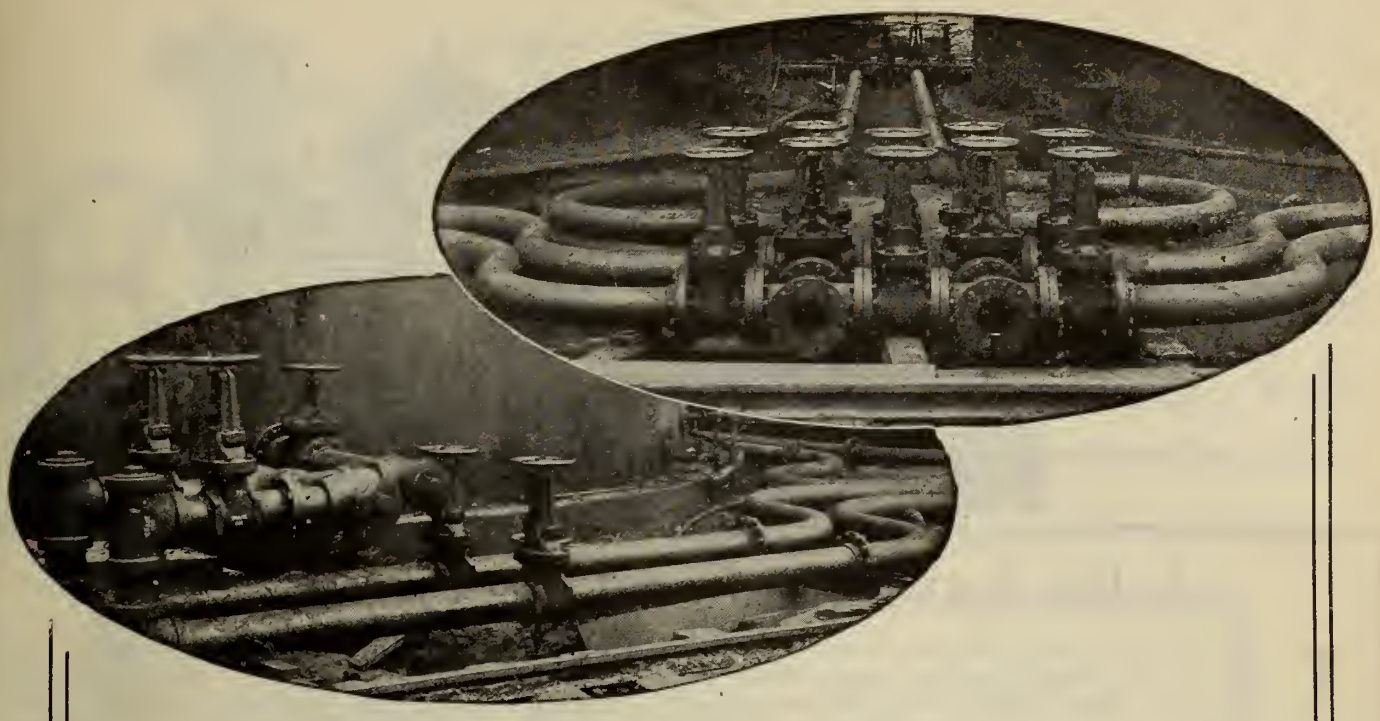

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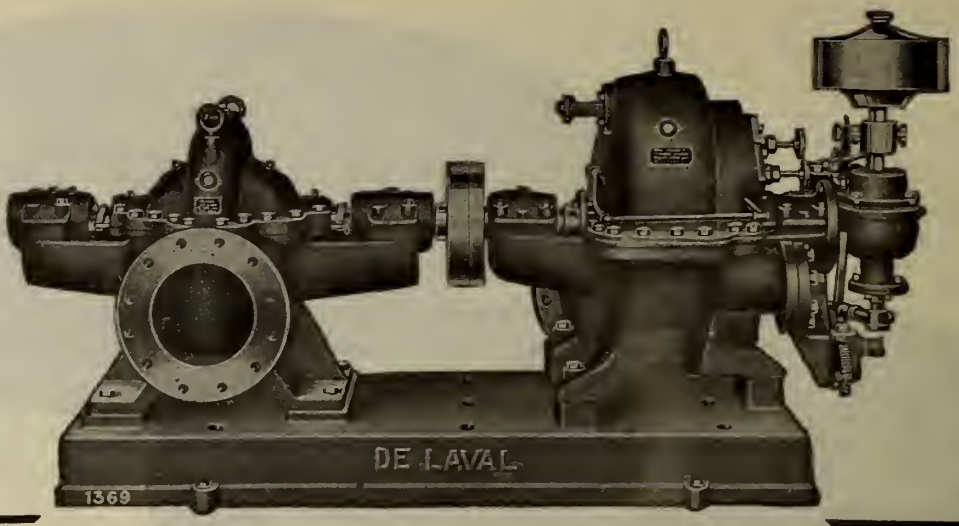

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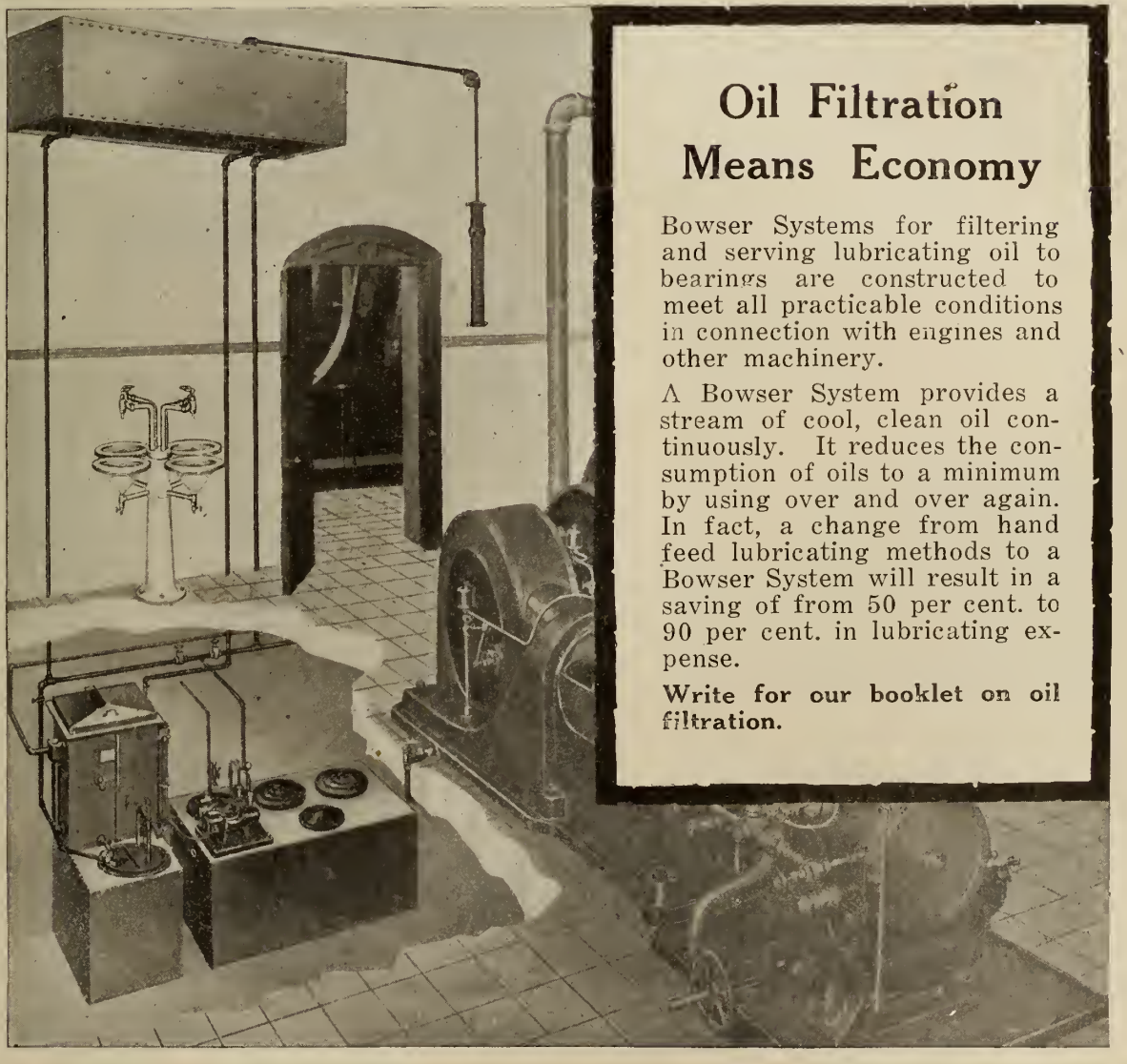

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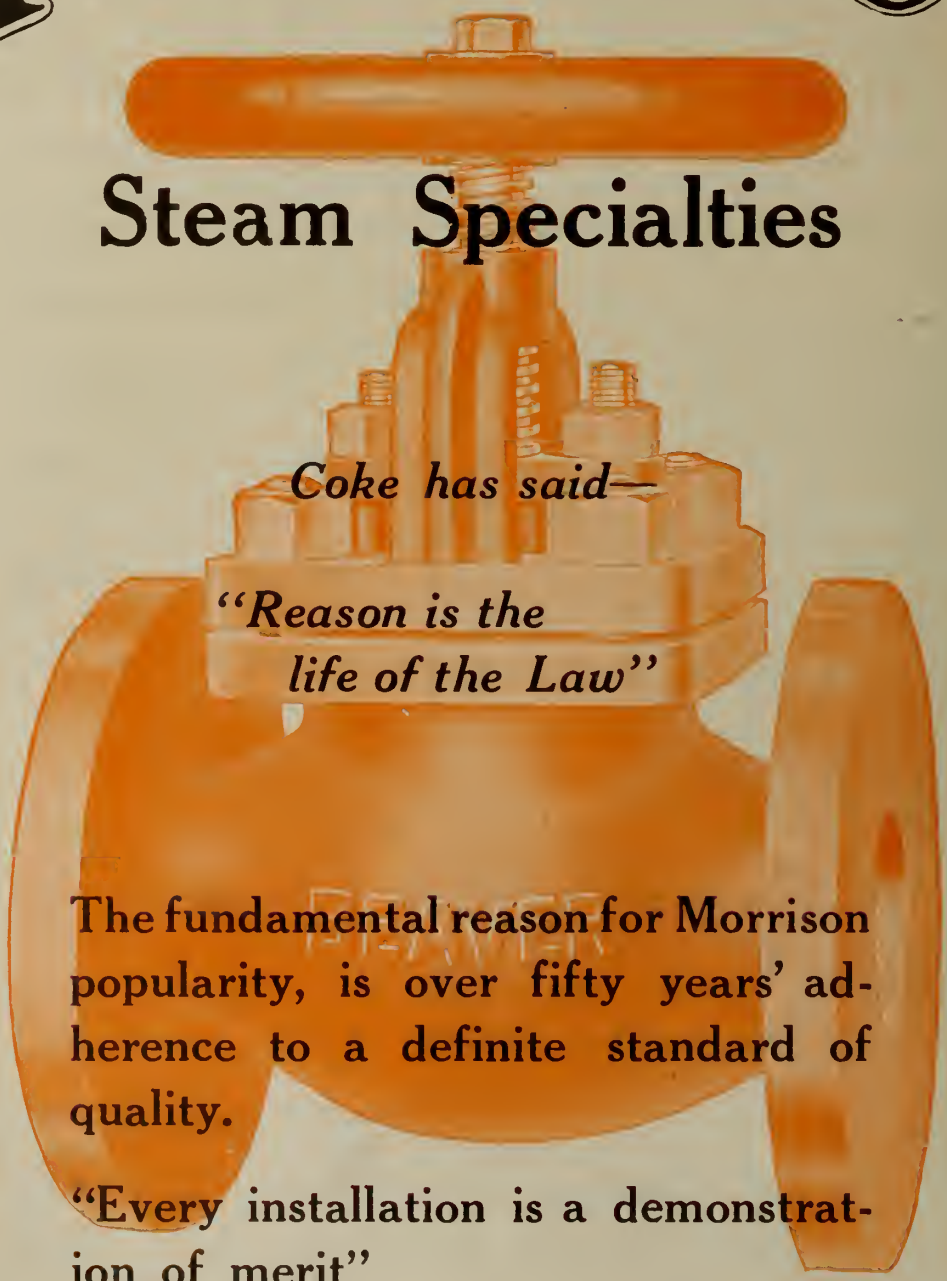

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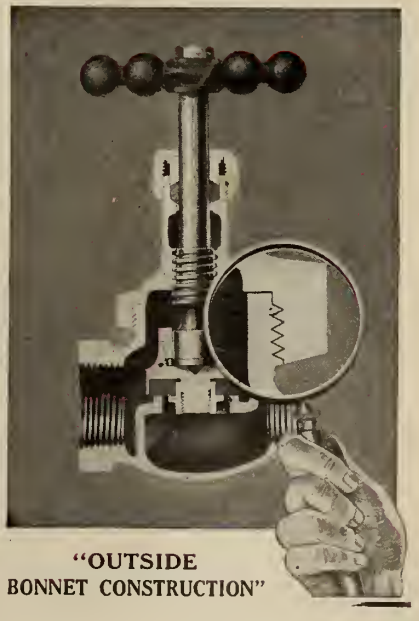

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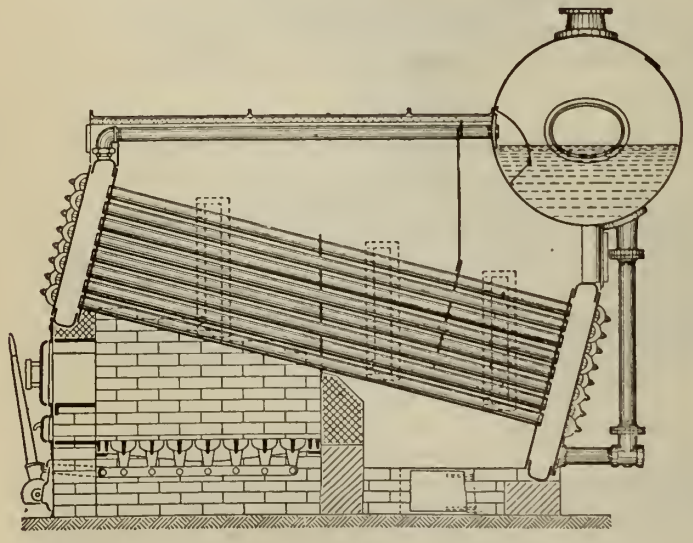

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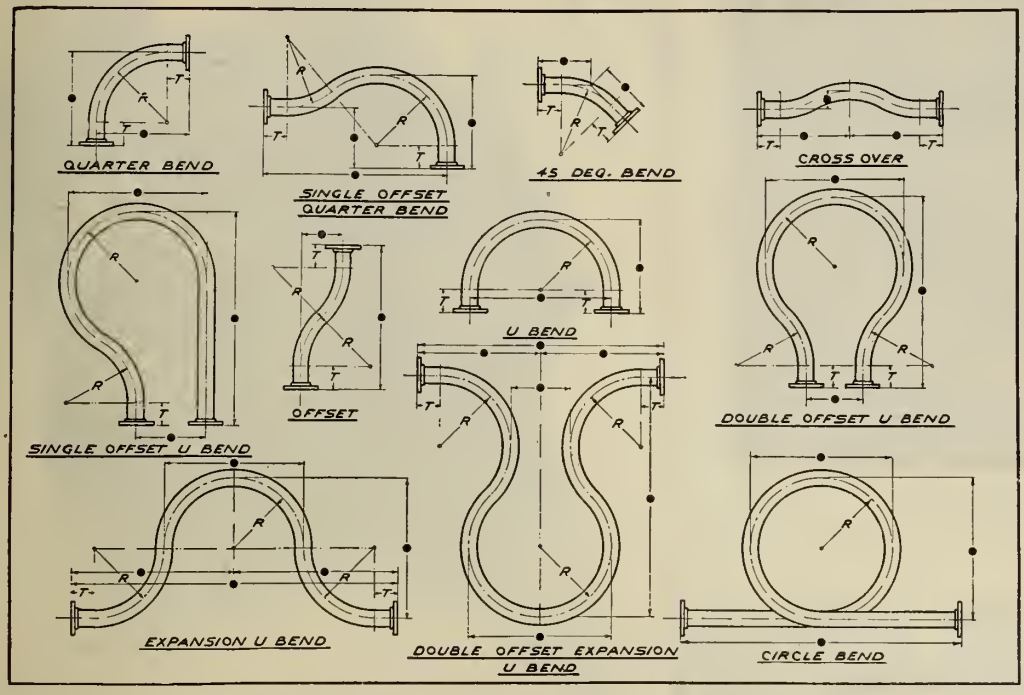

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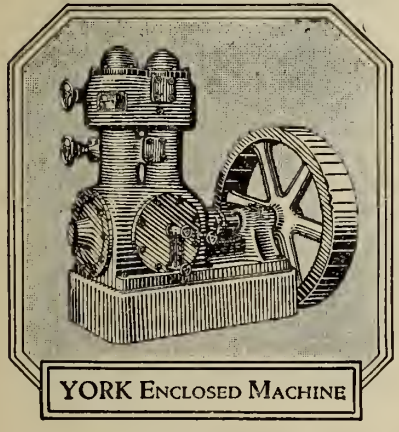

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Ice and Ice Cream Manufacturers, Meat and Produce Dealers, Creameries, Dairies, Confectioners, Grocers and many other industries are using York Mechanical Refrigeration profitably in the production and marketing of high grade products. If you require Refrigeration in your business, we should be pleased to have you investigate the York System.

Canadian Representative:

CANADIAN ICE MACHINE COMPANY
TORONTO: Villiers and Munition St., Eastern Harbor Terminals.
MONTREAL: .....324 Craig St. West
WINNIPEG: .....85 Lombard St.
CALGARY: .....605 Second St.

YORK MANUFACTURING CO.

(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA., U. S. A.

There is a YORK Plant to fit Your Business

Building a one-piece furnace lining without special forms or tools—No separate brick and no clay mortar joints.

Install New Boiler Furnace Linings and Baffles

Now, is the ideal time to re-line your boiler furnace, or put in new sloping baffles. Then you will avoid annoying delays and loss of time later on.

Permanent One-piece Linings and Baffles of

BETSON'S
PLASTIC FIRE BRICK

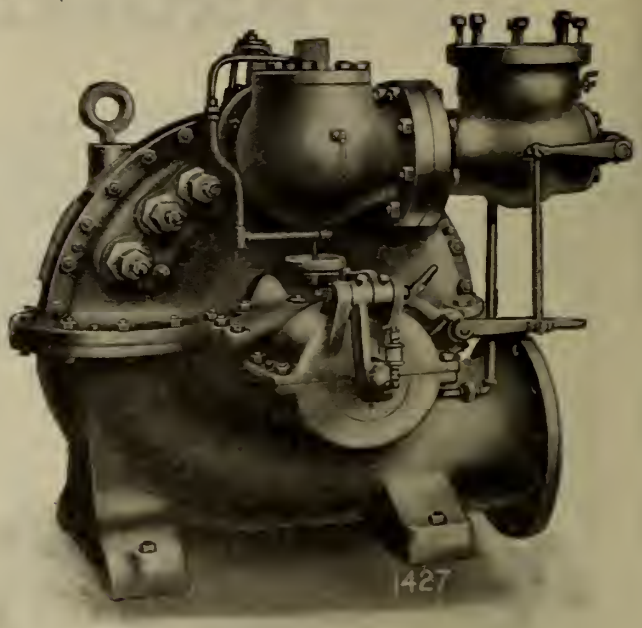
are easily installed without special forms or tools, even with inexperienced help.

The high temperatures reached by modern boiler furnaces, cause rapid disintegration of clay mortar joints, followed by complete destruction of the fire brick linings, arches, etc.

A solid one-piece lining, including front and back arches, side walls and baffles, costs but little to install in any make or type of boiler, and saves fuel, annoying shut-downs, costly repairs, and increases the amount of usable power from the fuel you pay for.

Complete details of the uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N. Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.
44-6 Lombard St., Toronto, Ont., Canada
"If it isn't Betson's, it isn't Plastic Fire Brick"



State steam conditions and characteristics of machine to be driven, so that we may send complete information

Efficient — But Simple

THE De Laval velocity-stage turbine is made of few, simple and readily accessible parts. The casing is divided horizontally in the plane of the centre line of the shaft, and the casing cover is also divided vertically, so that it is possible to get at the internal parts without disconnecting piping. The wheels and shafts are made of high-grade alloy steels, and the buckets and reversing vanes of drop forgings. The governing mechanism is effective and accurate.

Maximum efficiency at various loads is provided for by hand-controlled nozzle valves. De Laval velocity-stage turbines are ideal for direct connection to centrifugal pumps, such as boiler feeders, elevator pumps, service pumps, high pressure blowers and compressors, etc., and for driving small A.C. and D.C. generators. By the use of the De Laval speed-reducing gear, they are also applied for driving large standard-speed generators, low pressure fans and blowers, belt and rope drive, etc.

Ask for Catalog B-109

De Laval
Steam Turbine Co.

TURBINE EQUIPMENT CO., LTD.—73 King Street, West Toronto
THE LAURIE COMPANY—Bleury Street, Montreal, Quebec
TAYLOR ENGINEERING CO., LTD.—Vancouver

This Bulletin Points a Way to Boiler-room Economy

The crying need of the world to-day is ECONOMY—and still MORE ECONOMY—coupled with greater efficiency in production.

There is a host of ways to arrive at the much desired result, of course.

One of them—a tremendous help in reducing boiler-room losses—is the Vulcan Soot Cleaner. It reduces stack temperature, increases steam capacity and production, and decreases fuel consumption.

Send for a Vulcan Bulletin and let it show you how and why Vulcan Soot Cleaners are a vital necessity in the modern boiler-room.

The Bulletin shown describes the Vulcan Soot Cleaner for Stirling boilers. Other Bulletins are: No. 541, for B. & W. boilers; No. 547, Wickes; No. 550, Connelly, Badenhausen and Erie City Vertical; No. 552, Edge Moor; No. 556, Keeler, Geary and Union; No. 534, Return Tubular.
Ask for the one for YOUR boilers.

The VULCAN SOOT CLEANER COMPANY
MAIN OFFICE DU BOIS PA OFFICES IN THIRTY CITIES

WINNIPEG
William W. Hicks & Co.
567 Banning St.

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Green's Economiser Ltd.,
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Beveridge Supply Co., Ltd. MONTREAL

Keystone Fire Box Heating Boiler

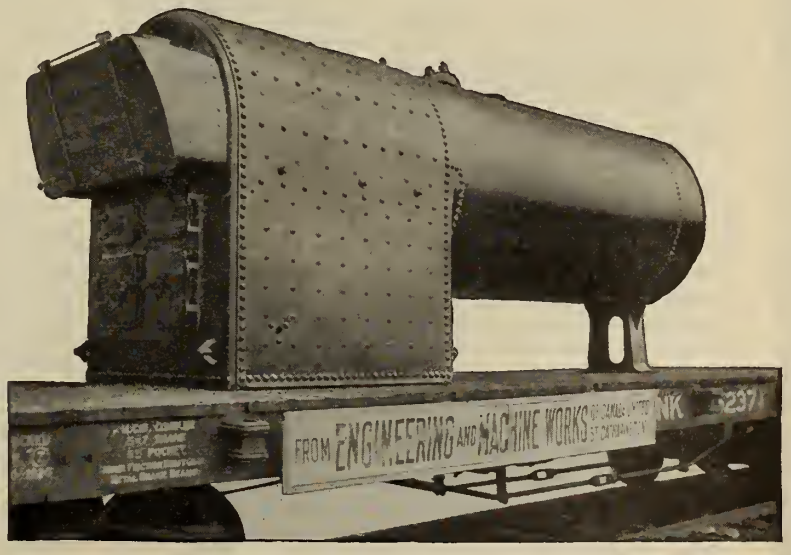
Here is a type of Boiler which we have been turning out with big satisfaction to our customers.

Well suited for Schools, Churches and public buildings of all kinds.

Built in various styles and in all sizes, and with smokeless furnace when required.

We also build the Keystone Excavator (Model 4).

Good service on deliveries.



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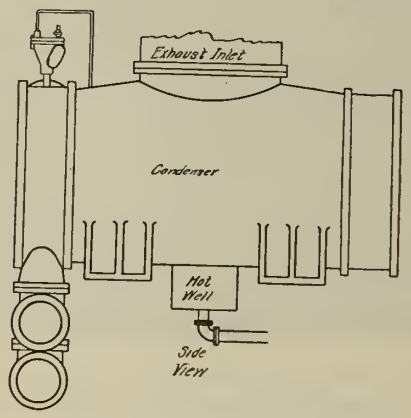

Eliminates Air
From Feed Water Heaters

The Des Moines City Railway Company has a circulating system of the siphon type, in connection with their condenser.

In order to reduce the amount of power used by the circulating pumps and also to keep the tubes in upper part of condenser shell free from air, they installed a

Fisher Automatic Air Trap
(Type 30)

on the water box of the condenser. The pressure on water box varies from one to two pounds above atmospheric pressure to several inches below, and condenser pressure is maintained at from one to two inches absolute pressure. This arrangement keeps circulating systems free from air at all times and prevents flow of circulating water from system to steam side of condenser.

They also have a vacuum heating system supplied from main boiler plant, returns being pumped direct to feed water heaters. They installed one of these air traps on air chamber of vacuum pump, which eliminated the necessity for frequent venting by hand and prevented waste of exhaust steam.

The Fisher Automatic Air Trap is adapted to many other uses. Let us send you our Bulletin No. 1001 which fully describes this highly efficient device.

THE FISHER GOVERNOR COMPANY
925 Fisher Avenue, Marshalltown, Iowa, U. S. A.
Agencies in all principal cities

Quick Action!
plus--

Constant Dependability

Not alone is it the Quick Action—nor the "plus" feature—but a combination of both that accounts for the high efficiency and wide preference for Homestead Quarter-Turn Valves.

Homestead Valves close with a quarter-turn and remain tight without dripping or leaking. A single quarter-turn of the lever opens them to a straight, unobstructed flow.

Use them on your Blow-Offs, Throttles, Tank Valves and every place where frequent opening and closing demands a valve that lasts! Made in straightway, threeway and fourway patterns with iron, brass, bronze and special bodies.

Write for catalogue.

Homestead Valve Mfg. Company
Homestead, Pa.

HOMESTEAD
Quarter-Turn Valves

Canada's Pulp Mills

After careful test and investigation the engineers in many of the big Canadian pulp and paper manufactures installed

Copes Boiler Feed Water Regulators

Some of these are:

LaCompagnie De Pulpe De Chicoutimi	6 orders
Spanish River Pulp & Paper Co.	8 orders
Abitibi Power & Paper Co.	3 orders
Spruce Falls Co., Ltd.	
Price Bros. & Co., Ltd.	8 orders
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Ha! Ha! Bay Sulphite Co., Ltd.	3 orders
Lake Superior Paper Co.	2 orders
Belgo Canadian Pulp & Paper Co.	2 orders
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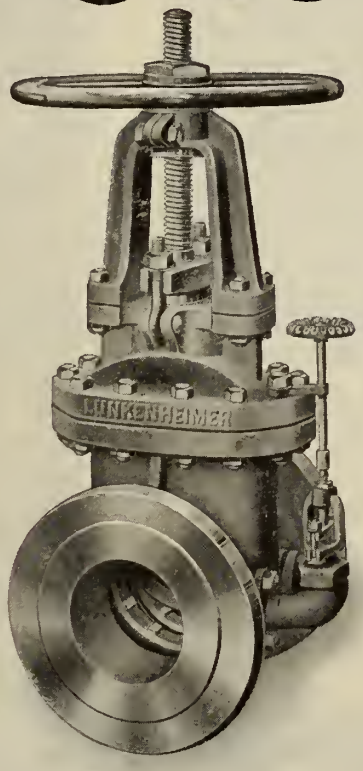
Copes Regulators save fuel and increase efficiency on their boilers. They can do the same on yours.

Write for Bulletin "D"

COPES
Northern Equipment Company
191 Barton Street, East
HAMILTON, ONT.

LUNKENHEIMER

"Victor" Gate Valves



Dependable performance is the service record of LUNKENHEIMER Iron Body Bronze Mounted "VICTOR" Gate Valves. The "VICTOR" solid wedge disc, double-faced and guided in its travel, is the most practical design of Gate Valve construction. It eliminates "dragging" across the seatring faces and the consequent wear prevalent in valves employing loose parts.

Highest quality materials, coupled with the LUNKENHEIMER method of manufacture; bearings bronze bushed to minimize wear; all parts, including the seatrings renewable, and the indestructible gasket between the bonnet and body flanges, all tend to enhance their value and insure longevity.

Made in both Inside Screw Stationary Stem and Outside Screw Rising Stem types, in four weights for pressures ranging from 100 to 250 pounds. Also in Quick-opening Sliding Stem type for pressures from 125 to 50 pounds, depending on the size.

"VICTOR" Gate Valves are also made in Bronze for pressures up to 250 pounds and in Cast Steel for pressures up to 350 pounds and temperatures to 800° F.

Specify LUNKENHEIMER "VICTOR" GATE VALVES and insist on their installation.

Distributors of LUNKENHEIMER Products situated in every commercial center.

THE LUNKENHEIMER CO.

"QUALITY"

LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD

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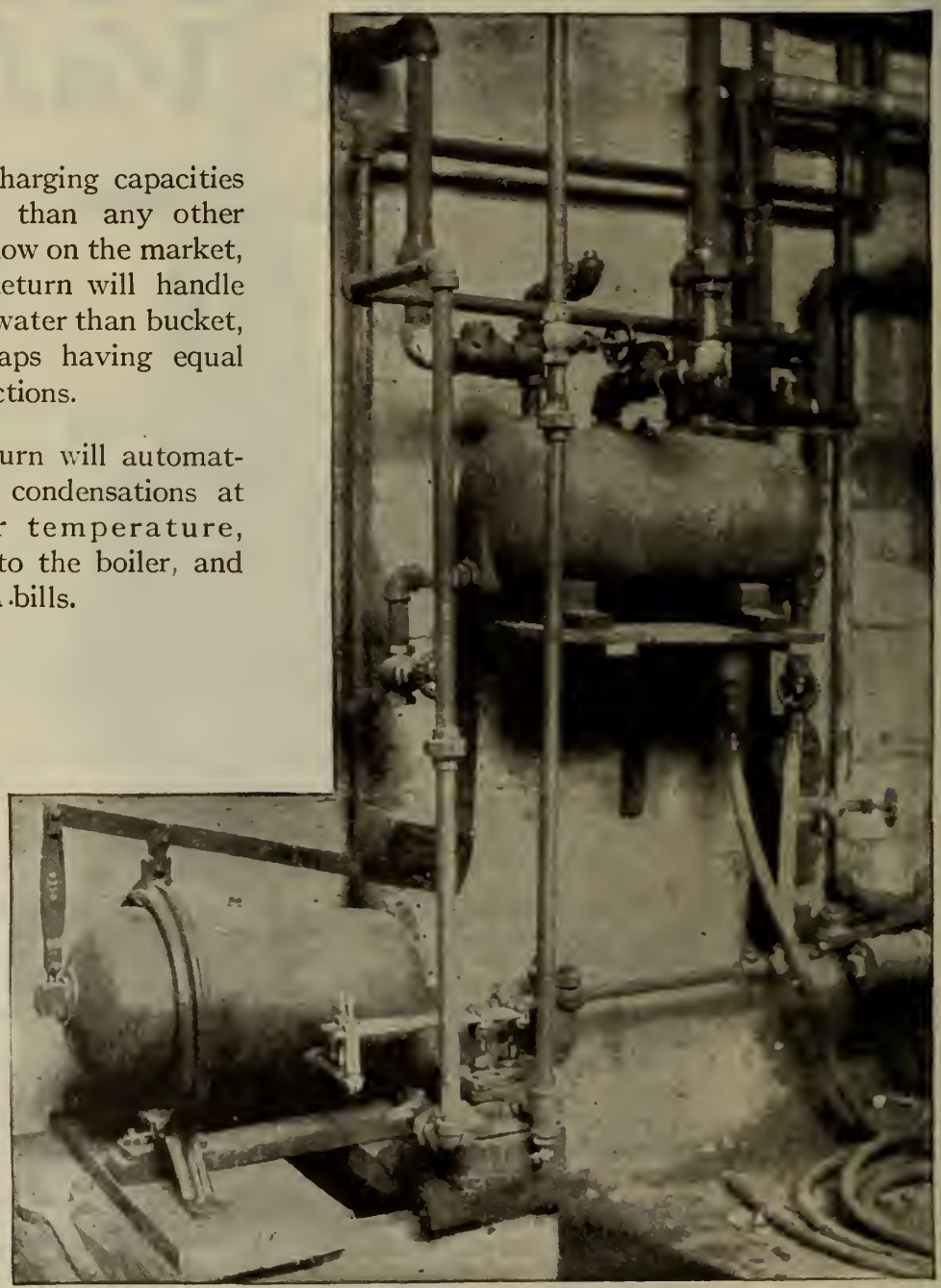
CRANETILT STEAM TRAPS SAVE COAL

THEIR discharging capacities are greater than any other style Tilt Trap now on the market, and the Non-Return will handle ten times more water than bucket, pot or float traps having equal size pipe connections.

The Direct Return will automatically return all condensations at any pressure or temperature, directly back into the boiler, and reduce your coal bills.



Manufacturers of Valves, Fittings and Piping Equipment, and Distributors of Pipe, Plumbing and Heating Supplies.

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10

DART

UNIONS

NEVER LEAKS

Because --

Every Union is fitted with a Bronze to Bronze face and seat which cannot rust or corrode, and the extra heavy iron parts which will stand without any signs of stretching or pulling apart.

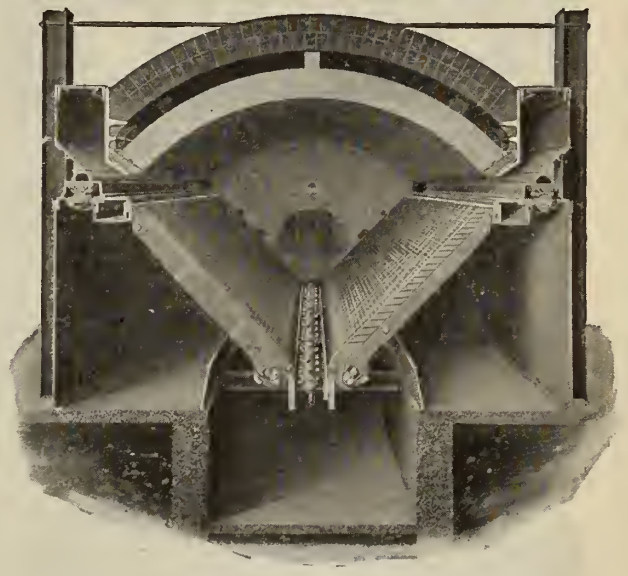
Dart Unions are invaluable from the standpoint of time, labor and worry saved, and satisfaction to customers.

A variety of styles to suit all requirements. Male and female union elbows. Male and female tees, on the run or on centre. Black or galvanized.

YOUR JOBBER SELLS THEM

Dart Union Co., Limited, Toronto

MURPHY AUTOMATIC FURNACES



For Any Boiler
50 h.p. and Up

Any boiler from 50 h.p. and up can be equipped with the MURPHY FURNACE. The *smaller plant* can therefore enjoy all the economical advantages of fuel and labor savings *without resorting* to forced draft.

To-day over *6,000 boilers* are fired by MURPHY FURNACES. You will find them used in nearly every branch of the industry—from hospital to industrial and central station service. MURPHY FURNACES "burn any fuel that has heat in it." They double the output of the plant "without one penny for draft."

Our Catalogue "HM-9" shows how MURPHY FURNACES can be installed under any type of boiler—50 h.p. and up.

For information on RILEY UNDERFEED STOKERS for large boilers, see advertisement in last issue or send for RILEY STOKER Catalogue "HR-9."

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

Are You Ready?

When demand comes for peak loads will it find your boilers ready?

PLIBRICO JOINTLESS FURNACE LINING

formed into side walls, bridge walls, baffles, front arches, and back arches when plastic, then baked and properly vitrified, is practically indestructible. Strong as rock and resists heat up to 3100° F.

Our book L-38 on "Modern Furnace Building" will tell you all about it. Yours for the asking.

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below. Warehouse stocks in all principal cities.

Distributors:

Beveridge Supply Co., Ltd., Montreal, Que; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman, Clancey & Grindley, Calgary, Alta.

STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN

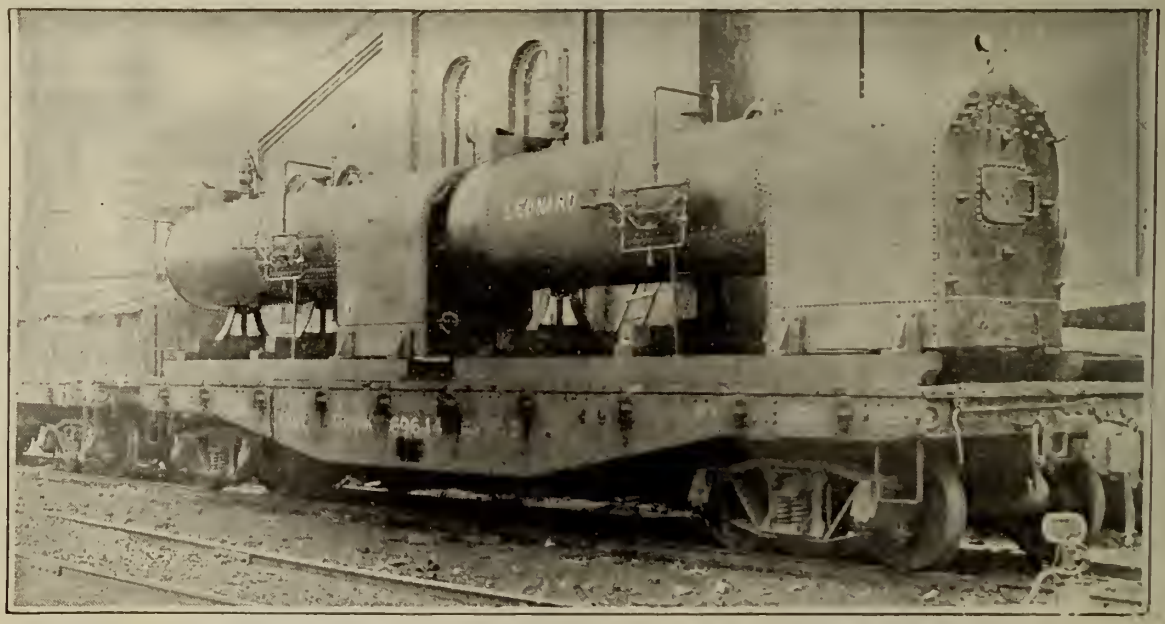
All **Made** to **Gauge. All parts interchangeable.** Give us opportunity to figure on your pumping requirements.

FIG. 7439
Packed Piston General Service Pump

We have full line of Patterns for direct acting steam pumps and belted or direct connected power pumps.

Established 1852

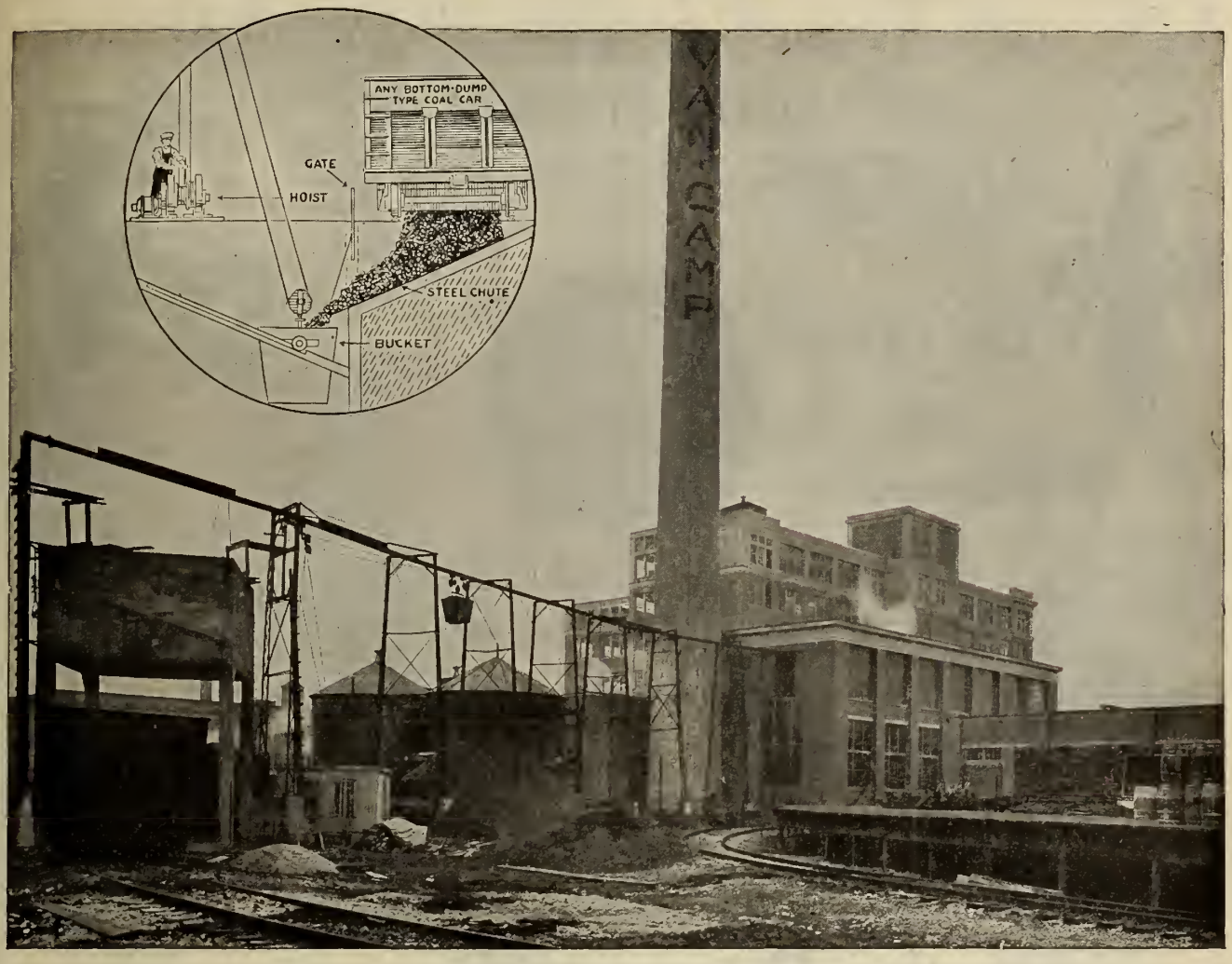
THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.



Two 60 H. P. Locomotive Boilers for 125 lbs. Under Ontario Regulations.

E. LEONARD & SONS, LIMITED
Head Office & Works, London, Canada
Branches and Agents from Coast to Coast.
Established 1834

LEONARD



Godfrey Monorail I-Beam Installation at Van Camp Packing Co.

Handling Coal and Ashes at Low Cost

with a

Godfrey Conveyor

THE Van Camp Company at their plant pictured above have been using a GODFREY CONVEYOR for two years to unload, store and reclaim their coal. The same system is used to carry their ashes from boiler room to an outside tank. During the time they have saved a considerable amount of money on the items of labor, demurrage charges and wasted time. Their coal is unloaded from car to storage by the service of only ONE MAN. No shovelling is required. Their Superintendent stated the cost of conveying coal to bunkers in boiler room is only SIX cents per ton.

Your Company Can Do the Same

Godfrey Canadian Engineers will be glad to make recommendations and estimates. No obligation whatever. Just tell us or them where and when.

Godfrey Conveyor Co.

Factory and General Offices:
127-147 13th St., Elkhardt, Ind., U.S.A.

Originators, Patentees and Manufacturers of Conveyors operating gravity-filled bottom-dump bucket over monorail

Represented in Canada by
M. A. KENNEDY, LTD.
106-110 Richmond St. West, Toronto
Phone Adelaide 7511

M. A. Kennedy, Ltd.,
106-110 Richmond St.
West, Toronto, Canada.

Please send descriptive literature, showing "Godfrey Conveyors" as advertised in September 20th issue of "Power House."

Company .....

City .....

Street .....

By .....

A Nearby Agency will Handle Your Orders
for Mason Specialties

Mason Appliances can be conveniently and quickly ordered from any of the branch agencies shown below. Forty years of dependable performance under all conditions is your assurance of accuracy, long life and low repair cost.

Bronze Body

Mason Standard Reducing Valve

reduces and maintains an even pressure of steam or air regardle s of other conditions. It automatically reduces boiler pressure for steam heating systems of all types. Also supplied in Iron Body.

Ashton Pressure Gauge

Ashton Pressure and Vacuum Gauges are hand graduated to insure absolute accuracy. Thoroughly dependable.

New Bundy Return Trap

Each Bundy is made for a specific duty—which it performs under all conditions. There are no reduced outlets so that Bundy Traps are sold, and can safely be bought, on their rated capacity. Rigidly tested under actual working conditions.

The Mason Regulator & Engineering Co., Limited

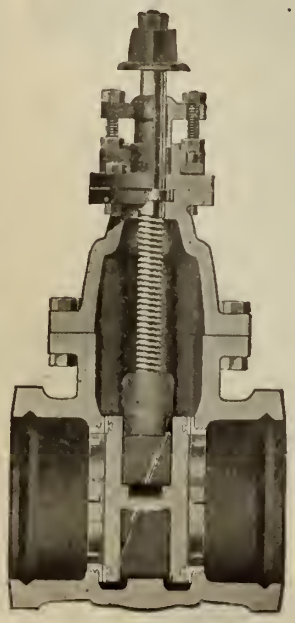
135-153 Dagenais Street MONTREAL, QUE.

Agencies at: TORONTO, HALIFAX, ST. JOHN, WINNIPEG, VANCOUVER

Made in Canada

DARLING
PATENTED

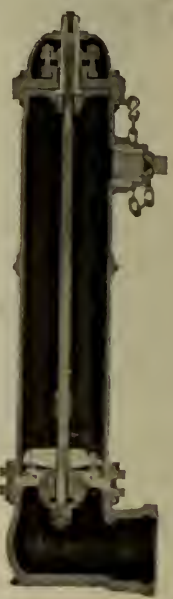
Fire Hydrants and Gate Valves



are known to the trade for their excellence of mechanical design, simplicity of construction, dependability in service.

ASK ANY USER.

Made in Canada



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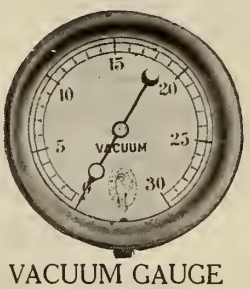
DOMINION STEEL PRODUCTS COMPANY, LIMITED

Dept "0". Brantford, Ont.

MORRISON'S

Steam Goods

"Every Installation a Demonstration of Merit"



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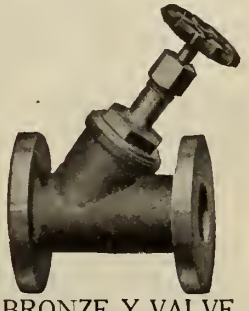
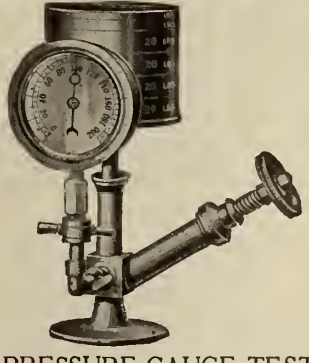


BRONZE Y VALVE



PRESSURE GAUGE TESTER

According to Hoyle!

In times gone by, Hoyle's Book of Rules was the indisputable arbiter to all controversies and troubles arising over the games of those days. Consequently the saying "according to Hoyle" took root.

Today Morrison's Steam Goods fulfill a purpose not unlike Hoyle's Book of old. For whenever troublesome specialties must be replaced Morrison's Steam Goods are usually chosen. They give long, unfailing service because they are built "according to Hoyle."

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West, TORONTO

FIRE!

Spontaneous combustion in oily waste is the cause of many fires in Paper Mills and factories.

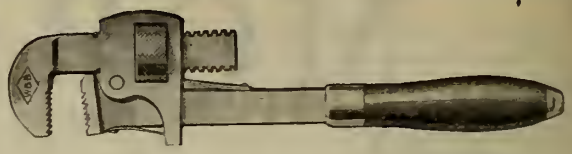
Eliminate this danger by using Reed's **"Firetite"** Waste Cans throughout your plant. The **"Firetite"** is stoutly built of galvanized steel with high legs and **Self-Closing Lid.** The price is right too.

Made in three sizes.

We shall be glad to quote you singly or in quantity lots.

Approved by Underwriters' Laboratories Inc.

GEO. W. REED & Co.,
LIMITED
MONTREAL



Behind

WILLIAMS'
Stillson Wrenches

there is half a century's experience in the manufacture of superior drop-forged tools.

Made in two models—wood and steel handle----and in 8 sizes from 6 to 48 inches, with capacities from 1/8 to 5 inches. At your dealer's.

Literature on request.

J. H. WILLIAMS & CO., Limited

"The Wrench People"

Formerly Canadian Division of
The Whitman & Barnes Mfg.Co.

78 Thorold Road St. Catharines, Ontario

KEEP YOUR BOILERS CLEAN
TO SAVE FUEL

1/8-inch Deposit on Tubes Increases Coal Consumption 30%
1/4-inch Deposit on Tubes Increases Coal Consumption 66%
1/2-inch Deposit on Tubes Increases Coal Consumption 150%

MILLER'S
BOILER CLEANING EXTRACT

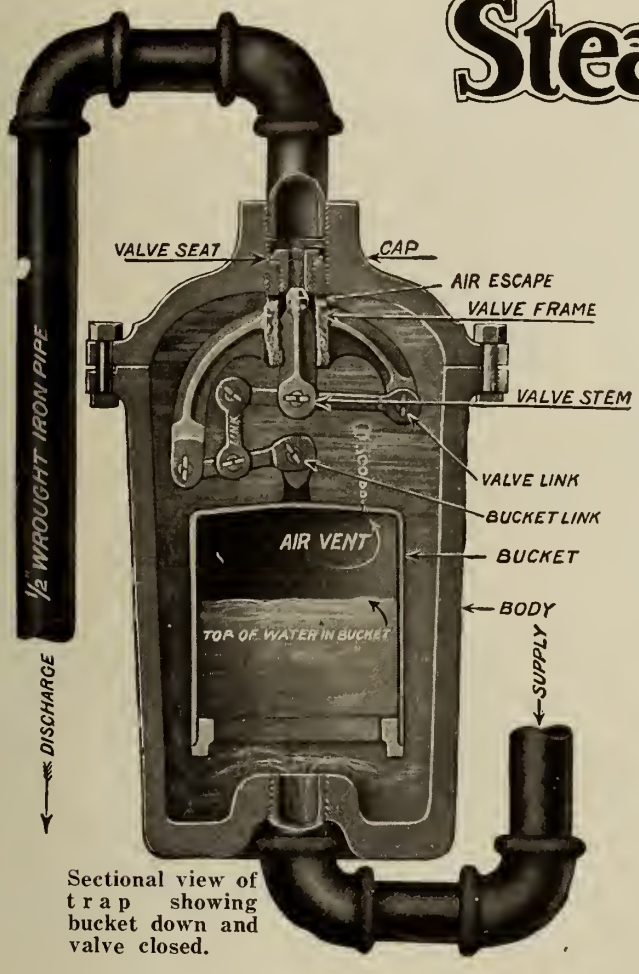
Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

TRY A CASK!

R. C. Miller Oil & Supply Company

38-40 Youville Square, MONTREAL

Armstrong Steam Trap



Sectional view of trap showing bucket down and valve closed.

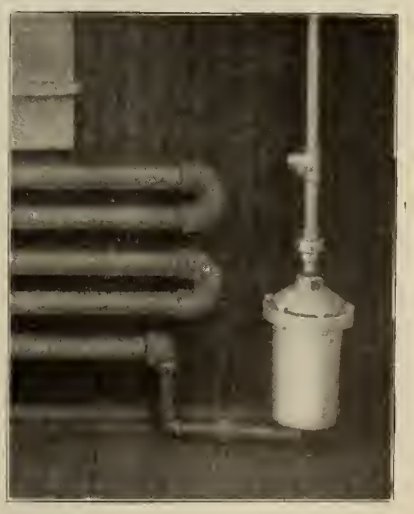
The Best Trap to Handle Condensation— Its Principle is Different

THE exclusive "Inverted Submerged Bucket" feature of the Armstrong Steam Trap mark it preeminently as the **best** trap to handle your condensation.

It absolutely will not pass steam. It will not become air-bound and is least affected by sediment, scale or oil. It requires a minimum of attention and upkeep; is compact, easily installed, and is of ample capacity for the work. Furthermore it is an economical investment, cost, capacity and upkeep considered.

THE Armstrong Trap is small in size and light in weight compared with the ordinary trap. It is easily connected and may be suspended on a pipe line; neither foundations nor pits are required. This and the fact that an Armstrong is self-cleaning and operates with little attention, is the reason for its widespread popularity with big power plants.

Write for details of our guarantee and 60-day offer



A No. 2 Armstrong Trap draining a low pressure coil in Fairbanks-Morse & Co.'s plant. Note the water seal at the trap. Holes in the floor are unnecessary as Armstrong Traps need not be set below the coil.

THE ARTHUR S. LEITCH COMPANY
LIMITED

1001-2 KENT BUILDING, TORONTO, ONT.

The real test of stoker service is the unexpected

In this plant nine 823 H. P. boilers are equipped with Jones "A-C" Stokers of 8 retorts each. The original order covered 7 boilers. Stokers for two more boilers were ordered later.

Write for "Ten Points of Jones Superiority"

How the Jones "A-C" meets the unexpected conditions that test a stoker's ability is told in this new book. The description of Jones "A-C" design and construction is complete but not long; thorough, but not highly technical. Where shall we send your copy?

Jones

Will Your Stokers Weather These "Ifs"?

TEST runs rate a stoker's efficiency—but there's nothing like the rough going of daily service to test a stoker's ability. After all, it's ability to cope with the unexpected that means most from the practical standpoint, for in power plants it seems the unexpected always happens!

Consider a few of the emergencies that are almost bound to arise in the average plant in the course of a year—the unannounced and unexpected "ifs." Will your stokers weather these "ifs"?

if —there comes a sudden demand for multiplied steam output—perhaps a boiler has been unexpectedly forced off the line—what then? Will you be at the mercy of ignition arches in meeting the peak load? Or will you depend on a stoker each retort of which is subject to the same rate of fuel feed? You can't expect best results if you do.

In a Jones equipped plant this emergency is easily met. The greater capacity of the retorts insures a large fuel reserve, so that even at highest over-rating the coal is completely volatilized *in the retort.* Eight ranges of speed of the Cole Automatic Valve (which actuates each steam ram) permit any rate of coal supply. And the rugged simplicity of the stoker itself affords stamina to withstand continuous forcing.

if —under unusual conditions, holes in the fire or uneven burning develop—have you a simple way of correcting such an error?

The operator of the Jones "A-C" has at his command an exclusive feature for meeting this emergency—individual control of retorts. Any portion of the fire can be accelerated or retarded at will. Individual control of retorts is practically a stoker essential, yet it is possible only in the Jones "A-C"—an inherent feature of Jones design!

if —foreign substance enters the coal hopper. Will it mean breakage and complete shutdown, or at least sheared pins and temporary shutdown when the stoker is most needed?

Any substance, such as wood or tramp iron, entering the Jones "A-C" hopper can cause no real damage. It merely stops the steam ram momentarily while the obstructing substance is quickly removed through the door in the hopper throat.

if —your fuel market changes over night, are you at the mercy of the mines?

Or can you call on these features (as every Jones-fired plant can): high, air-cooled side tuyeres to prevent clinker formation on side walls (when the coal is of stubborn clinkering tendency); automatic control of fuel and air (assuring correct ratio of fuel and air for efficient combustion); automatic-cleaning; individual control of retorts—to mention a few outstanding advantages.

If—but the whole story cannot be printed in limited space. You will find it in the book described on the opposite page.

The UNDER-FEED STOKER CO., of Canada, Limited
81 VICTORIA STREET - - TORONTO

Quebec and Maritime Provinces: The Cleaton Co., (Canada) Limited 403 Southam Bldg., Montreal, Que.

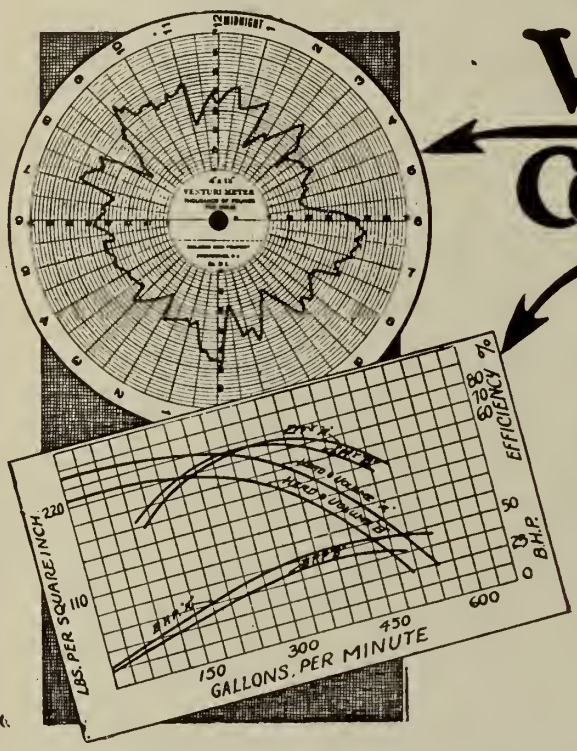
Alberta and Saskatchewan: Mr. J. Twomey, Camrose, Alta.

British Columbia: E. A. Earle, Ltd., 739 Hastings St.W., Vancouver,B.C.

Jones Stokers are made in Canada by Canadians, and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd. has recently been reorganized, and the reorganization makes available for Canadian power users the extensive engineering resources of the Under-Feed Stoker Co. of America.

"A-C" Stoker

Variable Volume
Constant Efficiency



THE REES RoTURBo — A Centrifugal Pump for Any Service

IN the "Rees-RoTURBo" we have the very latest development in centrifugal pump design. The disadvantages of the ordinary pump have been entirely overcome and it meets perfectly the conditions of to-day for high efficiency.

The fluid velocities are low, reducing friction losses to a minimum, and there is no wear even from gritty water, and high permanent efficiency is maintained. This means that the "Rees-RoTURBo" is ideal for multi-stage operation and may be said to be a pump for any service.

Should there be any point on which you would like to be enlightened, our engineering department is always at your service and without any obligation on your part we heartily invite enquiries.

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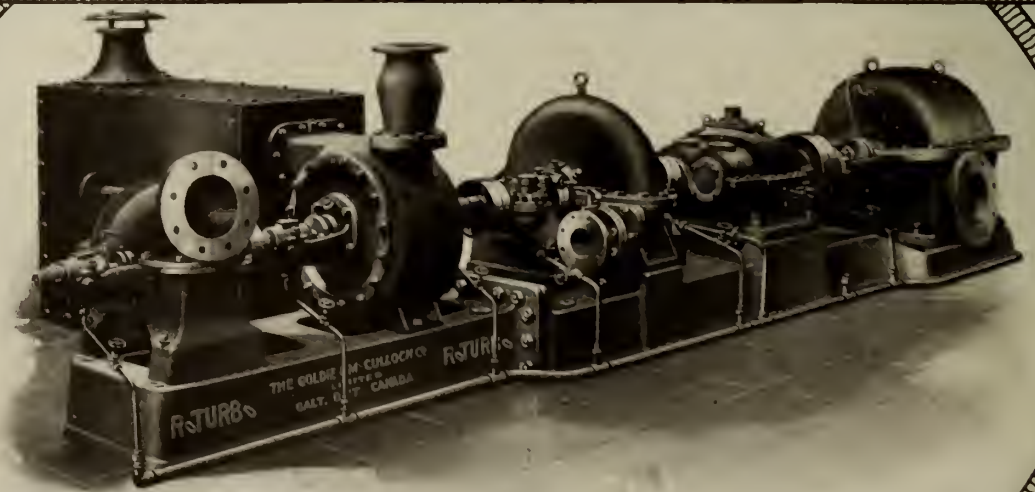
DEPENDABLE POWER EQUIPMENT



POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A 200 h.p. Uniflow Steam Engine

This Engine Manufactured by Galloways Ltd., Manchester, Has a Novel High Speed Valve Gear and Compression Release Which Were Designed by Mr. Pilling, General Manager of the Firm

LAST year Power House published an article on the Uniflow engine together with some comment on a discussion then proceeding in the pages of the "Engineer," of London. Through the courtesy of the same publication, we are now enabled to publish a description of a 200 h.p. engine of this type recently built by Galloways Ltd., Manchester, Eng. The most novel features in this engine are a shockless high-speed valve gear and a compression release device designed by Mr. Henry Pilling, the general manager of the firm. In other respects the general features of the engine follow orthodox uniflow principles; that is to say, the steam is admitted at the ends of the cylinders and is exhausted through a ring of ports midway in the cylinder walls, the ports being uncovered by the piston when it reaches about 90 per cent. of the working stroke and covered again at about 10 per cent. of the return or compression stroke. The advantages claimed for this arrangement are, of course, well known to mechanical engineers. The steam ports and cylinder walls adjacent to them are not subjected to the cooling action of exhaust steam rushing past them, while the exhaust ports are not exposed to live steam. In this manner cyclical fluctuations of temperature in the cylinder walls are greatly reduced; the temperature from the inlet to the exhaust portions falls gradually and surface condensation is prevented.

In the uniflow engine, as the whole of the expansion of the steam occurs in one cylinder, the cut-off takes place exceptionally early, actually at about 7½ to 10 per cent. at full load. The steam valve has, therefore, to be opened and closed again while the crank travels through from 25 deg. to 35 deg., or in one-fortieth to one-thirtieth of a second when the engine is making 160 revolutions per minute. The new hydraulic valve gear which Mr. Pilling has invented performs the opening and closing operations quietly and efficiently, joints and pins and other moving parts which are liable to wear being conspicuous by their absence.

Another characteristic feature of the uniflow engine is the high compression in the cylinder, which is brought about by the early covering of the exhaust ports. The clearance volume is such as to limit the compression to a pre-determined maximum when the engine is operating on a normal vacuum. The clearance volume is usually from 2 to 3 per cent. of the piston's displacement. With the clearance space fixed, therefore, it is obvious that a poor vacuum will cause an increase of compression in the cylinder, which might become excessive and dangerous if suitable preventive mechanism is not provided. In the engine under notice an automatic compression release device of original design is provided.

Fig. 1 is a sectional elevation, Fig. 2 gives a section of the cylinder and of the hydraulic valve gear, Fig. 3 shows the arrangement of the automatic exhaust gear, and Fig. 4 shows a set of indicator diagrams which speak for themselves. The engine is one of three intended for driving centrifugal pumps employed for drainage purposes in South America. The rated full load is 200 brake horse-power, the diameter of the cylinder 20in., stroke 24in., steam pressure at the stop valve 160 lb. per square inch, and the superheat 120 deg. Fah. The vacuum is obtained by a jet condenser and air pump driven from the engine crank shaft. The bed frame is a single casting supporting the two main bearings and the bored crosshead guide. In this frame the metal is disposed well along the lines of stress, the side walls being high. The bed frame is rigidly bolted to the foundation and the connection between the cylinder and the frame is by a circular spigoted joint. Being of comparatively small size, the

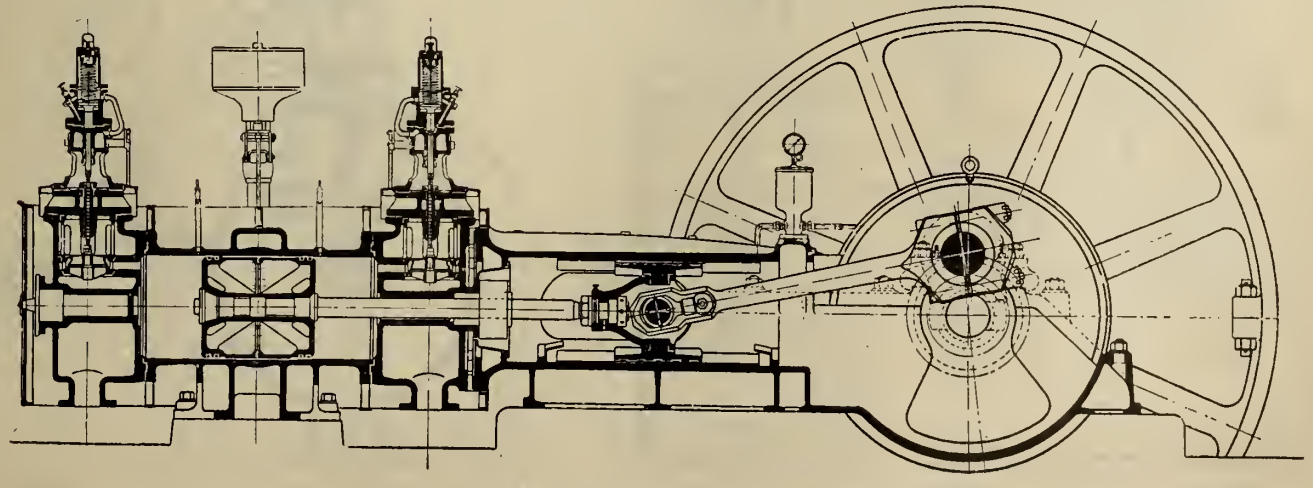


Fig. 1.—Sectional elevation of 200 H.P. Uniflow engine.

cylinder in this case is not of the patented built-up form of construction which has been adopted by Galloways for large cylinders. The cylinder casting the piston allowances are of course inner surface of the cylinder, as well as the piston rings can be inspected without moving the cylinder covers or piston. In boring the cylinders and turning the piston allowanres are of course made for the temperature differences which will occur in working, so that the clearance at all points of the stroke will be as uniform as possible. Each cylinder cover also acts as a valve chest and the steam ports are thus as short and direct as possible. The covers are steam jacketed, and in order to prevent the conduction of heat from the front cover to the bed frame the contact between these parts is restricted to pads or projections registering in the bed frame.

The piston—Fig. 1—is made in two parts, each with deep bosses fitting on the piston-rod. The two parts are spigoted near the outer cylindrical surface and held firmly together by conical faced nuts on the piston-rod. It will be seen from the sectional elevation that the steam valves are double seated. They are made of cast iron and of comparatively shallow depth, to give steam tightness under high temperatures. The new valve gear, Fig. 2, by which the steam valves are operated is a simple piece of mechanism. In this gear oil under pressure is applied below the plunger A, connected to the valve spindle B, and lifts the valve, which seats itself again by the action of a spring and dashpot C, when the fluid pressure is released. An eccentric on the lay shaft operates the ram D of an oil pump arranged in the valve bonnet. The pump ram is hollow and has a ring of slots or ports E, which at certain parts of the travel may be covered by a sleeve F surrounding the pump ram, the axial position of this sleeve being controlled by the governor. On the up-stroke of the pump oil is forced into the pressure chamber below the plunger, thus raising the plunger and the steam valve. At a point determined by the position of the governor the ports in the hollow pump ram overrun the sleeve and the oil escapes through the ports back into an oil reservoir. The steam valve is now free to close under the combined action of the spring and the dashpot piston, the seating of the valve being both rapidly and quietly performed.

We have had the opportunity of seeing the valve gear in operation with the engine running at 160 revolutions per minute. It was remarkably effective, giving a perfect control of the cut-off at any point from zero to about 60 per cent. of the stroke, and it operates with absolute silence. The prominent features of the valve gear are its compactness and the small amount of power required to operate it. The indicator diagrams serve to show how delicately the gear acts. They were taken by varying the position of the governor sleeve by hand while the pencil was kept continuously on the paper.

The other feature of special interest is the automatic compression release gear shown in Fig. 3. From the drawing it will be seen that two supplementary exhaust valves G H of the mushroom type are arranged on the side of the cylinder. These valves open inwards and are kept normally closed by the springs J K which act in conjunction with the pressure of the steam. On the engine lay shaft is a sleeve L carrying two cams M N of tapering form, which are capable of longitudinal movement on the shaft. The axial position of the cams is made to correspond automatically with the vacuum in the condenser by a spring controlled piston O, of a small cylinder P, mounted at the end of the lay shaft. One end of the cylinder is open to the atmosphere and the other to the condenser. The piston operates the cams by means of the rod R. Under normal conditions of vacuum the small end of each cam is just clear of the roller on the supplementary exhaust valve stem and the valve remains seated; but if the pressure in the condenser rises, the piston in the vacuum cylinder moves out and by means of the rod R the cams move axially, so that they allow the exhaust valve to open during a portion of the compression stroke, as shown in the drawing, Fig. 3. The amount and duration of the valve opening depend exactly on the axial position of the cams and thus increase as the back pressure rises. It should be noted that under normal vacuum the valves, valve guides, and rollers are absolutely out of action. The gear has thus few moving parts, and absorbs the minimum of power. As the engine operates its own air pump it has to start up without vacuum, and this gear gives full relief of compression until a vacuum is established, then permitting the compression to increase until the full compression at normal vacuum is reached. This means that the engine need only be barred round to the starting position after which starting is effected entirely by opening the steam stop valve. We had an opportunity of witnessing the operation of the compression release gear and can testify to its efficiency, both at starting and when the vacuum was purposely destroyed by admitting air through the "vacuum breaker" valve.

A short preliminary trial of the engine was carried out at Galloway's works before shipment. The engine was run at full load and speed, the power generated being measured by a

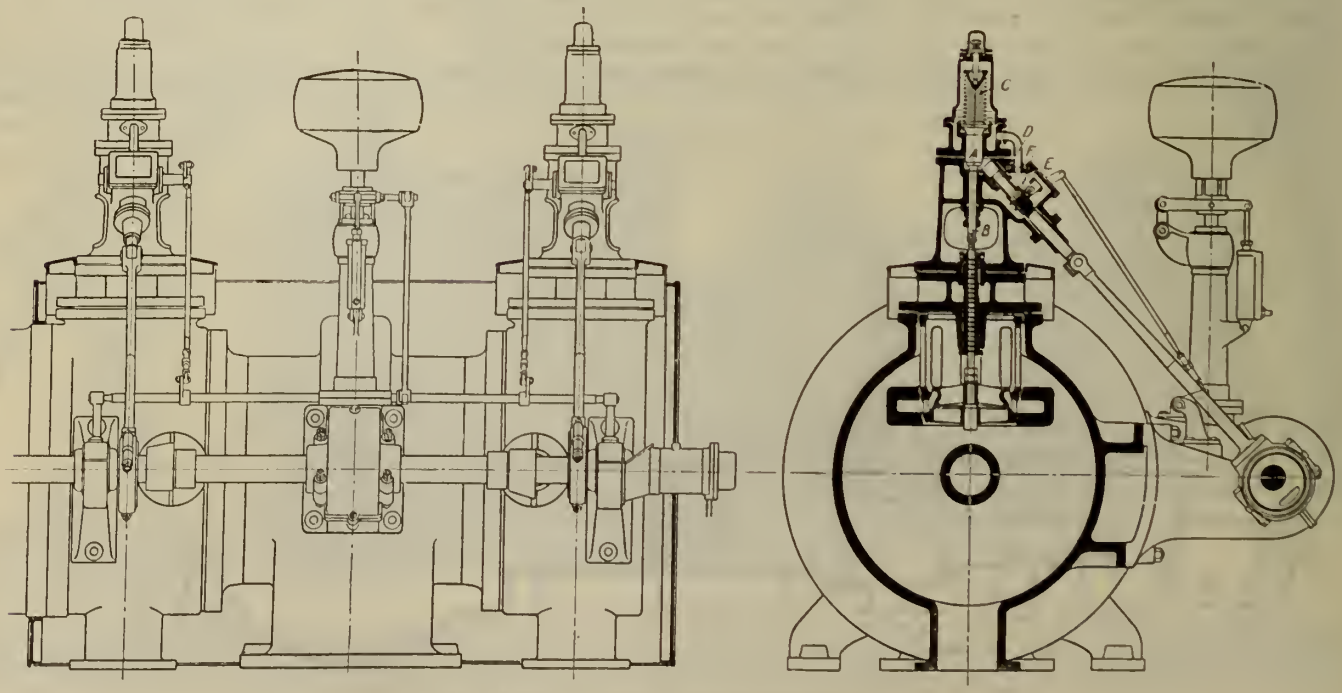
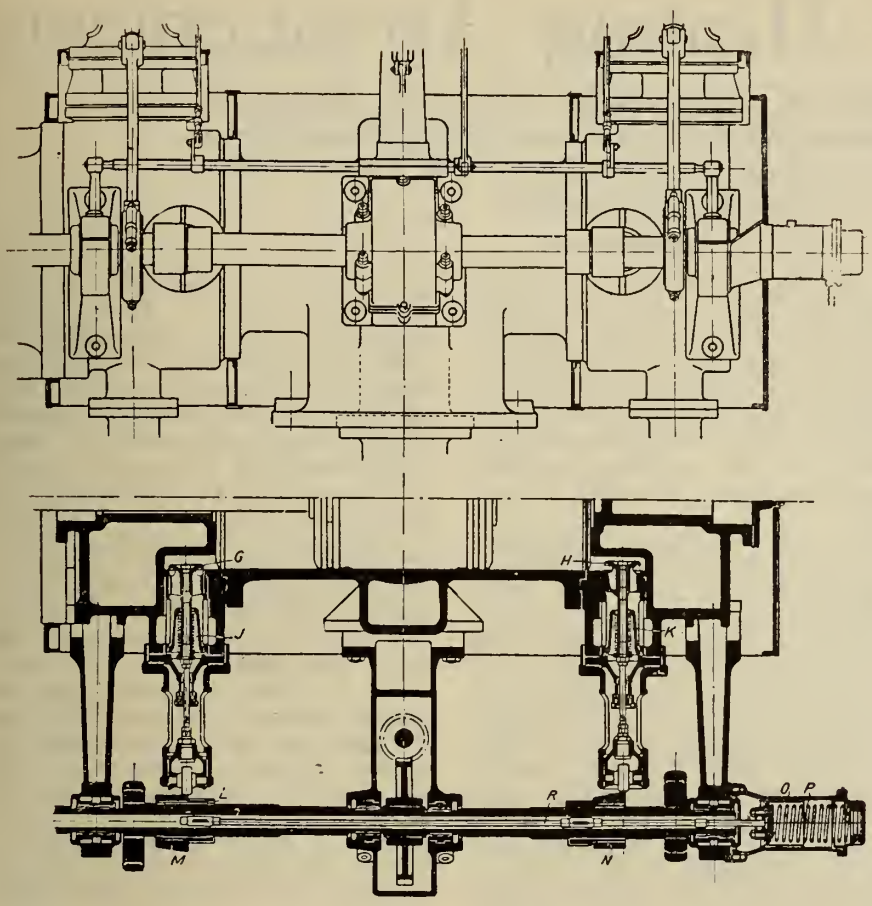


Fig. 2.—Side elevation and cross section.



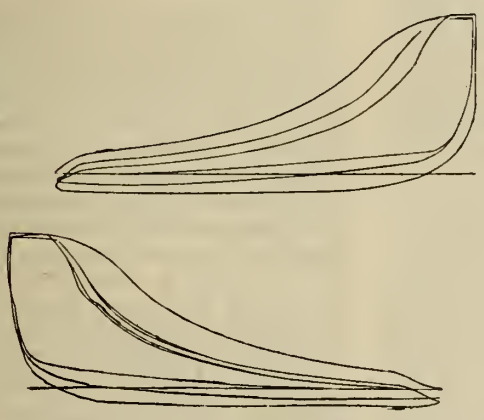


Fig. 3.—Arrangement of the automatic exhaust gear. Fig. 4.—Indicator cards.

Heenan and Froude dynamometer. As no surface condenser was fitted at the time the steam consumption was measured by observation of the boiler feed. The boiler being the same that was used for the heating system of the works with heating pipes blanked off, neither the specified boiler pressure nor superheat was available. The piping arrangements were also temperary, the stop valve being about 20ft. from the cylinder. The pressure and superheat at the stop valve were 125 lb. per square inch and 50 deg. Fah. respectively, and in spite of these adverse conditions the results of the tests, after making the necessary allowances for the change of pressure and superheat to the specified valves of 160 lb. per square inch and 120 degrees Fahrenheit, confirm the figures guaranteed, namely 12.6 lb. of steam per brake horse power hour which must be considered extremely satisfactory for an engine of such a comparatively small size.

PUTTING WASTE VAPOR TO WORK

The method employed to increase the capacity of a heating plant for a paper mill was described recently by W. H. Howell, Jr., before the technical association of the pulp and paper industry. The capacity in this particular case was increased by the proper utilization of waste vapor and Mr. Howell stated the usual practice has been to heat fresh air from outdoors by carrying it over steam coils, blowing it into the room and taking out the moisture from the driers either by having openings in the roof or with exhaust fans. This system has been quite highly developed and gives satisfaction provided it is properly installed.

At the mill referred to, this old system was in use, but as the production was increased 100 per cent. it was found to be inadequate. It was then arranged to ventilate the machine room with two fans. One exhaust fan is used for pulling moist air out of the machine hood to the economizer and a supply fan distributes the warm air and the fresh cold air crisscross each other in the economizer without actual contact except through corrugated plates. The object of the corrugated plates is to enable the closest possible contact for transmission of heat from hot moist air to the cold fresh air, at the same time separating the moist air from the dry air. Both fans are belt-connected to a single 20-horsepower constant-speed electric motor.

In average winter weather (34° Fahr.) the economizer is able to raise the outdoor air to 107° Fahr. for distribution in the machine room in quantity sufficient for all ventilating purposes and without the use of any steam whatsoever. This result is accomplished solely by utilizing the waste vapor going out of the machine hood and still leaving a large quantity of vapor available for other heating purposes.

It was found that 107° was too warm for the comfort of the operators, and a certain amount of moist air was consequently allowed to escape into the atmosphere without passing through the economizer, so as to bring the air temperature supplied to the room down to 98° or 100°.

Mr. Howell stated that, so far as he knows, this is the first practical use of the idea on a large scale for heating and ventilating a machine room without the use of steam from the boiler plant. By its means first-class ventilation conditions are assured in a place that formerly presented a very difficult and expensive operating condition. Of course the intention is also to use such waste heat in some cases to assist drying operation in the summer.

BULLETIN

The Bailey Meter Company have issued Bulletin No. 6 describing briefly a number of their different types of meters for various services. An illustration of a minature gas fired boiler, built to one eight scale of a 1024 h.p. cross drum water tube boiler, with glass drum heads and one side of the setting made of glass is on the front page. This is used in conjunction with a type D 25, Class 56, meter, which records Steam Blow, Air Flow, and Gas Temperature, and indicates Fire Box draft. Bulletin 42 contains complete description of the Bailey Boiler Meter.

Back Pressure Heating Arrangements

The Following Remarks Contained in the Chief Engineer's Report to the Manchester Steam Users' Association, Should Help to Make This Interesting Subject More Clear—The Thermal Side is Treated Very Lucidly

By C. E. STROMEYER

ALTHOUGH the principles on which heating by means of exhaust steam from engines is based are well understood, it seems advisable, on account of the somewhat complex nature of the subject, to restate these with the help of a few simple diagrams.

The heat equivalent of one horse power per hour (550 foot pounds per second) is 2,540 British thermal units. It can be represented by the heat contained in 2 pounds of high-pressure superheated steam, or by the heat of combustion of 0.2 pounds of ordinary coal of, say, 12,700 B.T.U.'s.

It is very desirable throughout the following considerations to disabuse our minds of the notion that ten, twenty, or more pounds of steam per hour are one horse power. Steam is merely the conveyor of power, as copper wire is the conveyor of electricty. This conveying power is limited. For instance, a copper wire would fuse if too much electricity were passed through it, and in practice a limited quantity, say, one and two thousand amperes per square inch, are found practicable. Similarly with regard to steam and power. One horse power is represented by the evaporation or condensation of about two pounds of water or steam per hour, but in practice more than ten and sometime up to fifty pounds of steam have to pass through an engine to produce one horse power. The heat contained in this large quantity of steam is wasted, all except that represented by 2-1 pounds of high pressure steam. It is either blown into the atmosphere or into the condenser. Back-pressure systems aim at utilising this enormous waste for heating purposes. A customary condensing engine of, say, 100 h.p. will have a steeam consumption of say 1.4 lbs. per I. H.P. per hour. The heat supply to the boiler will be equivalent to 1500 lbs. high pressure steam. The chimney losses and radiation are equal to 450 lbs., leaving 1050 lbs. to be supplied to the engine. The engine uses only 210 lbs. of this, 840 lbs. being rejected to the condenser. This 210 lbs. is equal to 100 H.P.

A non-condensing high-pressure engine would have a heat supply to the boiler equal to 10570 lbs. The radiation and chimney loss will be 3170 lbs. The steam supply available for the engine will be 7400 lb. and using the same amount of steam in the cylinder to produce 100 H.P. and exhausting against 60 lbs. absolute back pressure, 7190 lbs. steam are available for further use.

If instead of 60 pounds absolute back pressure, as assumed in the second case 30 pounds absolute or 15 pounds above atmosphere were to be adopted, the weight of exhaust steam per hundred h.p. would be about 5,300 pounds instead of 7,190, the steam supply to the engine 5,510 pounds, the chimney waste 2,360 pounds, and the heat supply to the boiler would be equivalent to 7,870 pounds steam, say, 730 pounds ordinary coal.

In the non-condensing engine there would be available for heating purposes at 45 pounds pressure, or 292° Fahr., about 7,190 pounds of steam per hour, capable of heating about 3,600 gallons of water per hour to boiling point. In the second case the available pressure would be 15 pounds, with a temperature of 250° Fahr., and its heating capabilities would be 2,650 gallons per hour. In both cases the 100 horse power would cost practically nothing, viz. 210 pounds of steam, or 20 pounds of ordinary coal. In other words, when all the steam can be utilized for heating or other purposes the power derived from it costs nothing. It is obviously, therefore, highly enconomical for those works which use much steam for heating, to produce power with it and use or sell it; and those works which produce much power might sell their waste steam for heating purposes.

Those cases in which the heating requirements are greater than can be obtained from the engine exhaust, although relatively few in number, are of great importance, and as is these works there is much scope for electric heating, it is desirable to consider whether some of the exhaust steam could not be converted into electricity. Assume that one of these works requires an effective back pressure of 15 pounds and 5,300 gallons of boiling water per hour. Two engines of 100 h.p. each could be run in these works, the one driving the machinery either direct or by means of electricity and the other producing electricty for heating purposes, equal to an additional 105 gallons of boiling water. Heating by electricty, especially when it costs practically nothing, has many advantages. High pressure steam vessels in the midst of factory hands could be dispensed with, and any desired temperature could be attained without having to contaminate the air with burnt gas. Therefore, in all those works where direct heating is done by low pressure boilers there is a probability that much heating might be done by electricty without extra cost.

The majority of works require less heat than that which is at present discharged by their driving engines assume a case where the available back pressure has to be 15 pounds, then if the heating requiremests are 4,500 pounds steam, or, say, 2,250 gallons of water, it would, from an economic point of view, make no difference whether these 4,500 pounds of steam were drawn direct from the boiler, costing the equivalent of 6,370 pounds of steam plus 1,500 pounds for producing 100 horse power (total 7,870 pounds), or whether the exhaust steam from the engine were used, which, as shows above, amounts to 7,870 pounds. In this case, of course, the difference between 5,300 and 4,500=800 pounds of steam would be blown to waste, and the thought naturally presents itself that this portion of the steam should not enter into the back pressure main at all, and, therefore, not through the non-condensing engine but should be passed through a highly efficient condensing engine. This is essentially the principle on which extraction engines are designed.

Before deciding whether a back-pressure system of heating is to be adopted it is essential to know the steaming and heating requirements of a factory. If they exceed say 20 to 25 gallons of boiling water per hour one horse power, then a back-pressure engine should be advantageous; if the requirements are less, then an extraction engine, or live steam heating combined with a very efficient engine is more economical, but the engine has to be very economical, In practice the fuel expenditure is more often above 2.8 pounds of coal per one h.p., than 1.4 pounds as here assumed, whereby the relations are materially modified. The limit between the use of live steam and back-pressure steam would, therefore, in practice, be reached when the heating requirements are about 15 to 20 gallons per hour per indicated horse power. Of course, wherever non-condensing engines are used, it is certainly advantageous to employ the exhaust steam for heating purposes.

The difficulty of deciding on the best plan to be adopted is due very generally to ignorance as to the relative steam consumption in engines and heating appliances, but the ever-increasing accuracy of steam meters should make it possible nowadays not only to measure steam consumptions for reorganisation purposes, but also subsequently to check the waste of individual steam consumption appliances.

Manufacturers who may wish to utilise their back pressure for heating purposes will have to consider the question of adapting their engine to this pur-

pose or whether it would be advisable to replace it by a back-pressure turbine. A rough but reasonably accurate rule is that a condensing engine making 60 revolutions per minute develops from 8 to 10 horse power per cubic foot, plus 25 per cent. for the high pressure cylinder in cases of compound engines. This estimate applies to engines in which the absolute back pressure is about one-third of the absolute boiler pressure. It has to be reduced by about 25 per cent. if the back pressure is one-half of the boiler pressure.

There is, therefore, no difficulty as regards size of engine in changing from the condensing principle to the back-pressure principle, but most low-pressure cylinders are very weak and would have to be replaced by stronger ones of the same or smaller dimensions. When such a change is under consideration the advantage of using a back-pressure turbine should not be overlooked. That advantage is that the exhaust steam is not contaminated with grease and can be blown direct into the water to be heated, without the intervention of heaters and coils of pipes.

The cylinders of a simple high-pressure condensing engine will always be both large enough and strong enough for conversion into a back-pressure engine.

In some works much power and steam are required during the day, and little power, but the same quantity of steam, at night. These cases could usually be met by lowering the pressure during the night and using steam direct from the boilers. The reverse conditions —power night and day and steam for heating during the day—could be met by bifurcating the exhaust, and fitting two large valves, the one opening to the condenser the other to the back-pressure system. With compound engines the arrangement is more complicated.

Many recommendations have been made to abstract steam for heating purposes from the engine at some convenient intermediate pressure. Theoretically, as already pointed out, a saving can be effected by this means, but unless the demand for steam for heating is steady this system introduces fluctuations into the engine speed which cannot well be met, except by the use of two governors. The nature of this difficulty will be apparent by once more glancing at the back-pressure engine. Assume that a back-pressure engine is being supplied with steam of 150 pounds absolute and exhausting against a pressure of 60 pounds absolute, then if the demand for power be increased, the governor would increase the steam supply by shifting the cut-off. But this increase would also increase the back-pressure and, under certain relations of pressures, the result would be a reduction of power. Then also if there should be a sudden heavy demand on the back-pressure steam, the power would naturally increase above requirements and the governor would reduce the steam supply and cause the back pressure to sink still further. This difficulty can be met, within limits, by throttling the exhaust, but in a paradoxical way, the exhaust throttle valve having to be closed more and more as the back-pressure sinks. The first effect would be to reduce the power, but then, of course, the inlet governor would admit an extra quantity of steam as required. In other words, the greater the demand for back-pressure steam, the horse power remaining constant, the more inefficient will the engine have to be made, and the simplest plan for doing this is to rise the back pressure. The several pressures can, of course, be regulated by the cut-off and exhaust, or, rather, compression arrangements.

Supplementary means of maintaining a reasonably contant back-pressure is to instal throughout the works in convenient situations large thick-walled vats or metal reservoirs for storing hot water. Here also two regulators would be necessary, one for shutting off the cold water supply whenever the temperature of the contents approached 212° Fahr., and one for increasing the steam supply with increasing back-pressure. If ordinary greasy engine exhaust be used the reservoir water will have to be heated by means of steam pipes and then provision must certainly be made for thoroughly scraping all steam grease out of the pipes. If the back-pressure turbines are used the steam can be blown direct into the reservoir waters.

In very many works reservoirs of boiling water would effect a great saving of time, would obviate inconveniences, and in chalky districts the heating of the water would precipitate most of the lime salts. With a 6 or 9-in. non-conducting covering for these tanks their loss of heat should not exceed about 0.05 pounds of steam condensed per sqr. foot per. hour. A cylinder vessel 6 feet diameter and 10 feet high, holding about 16 tons of water should therefore not lose more heat than is represented by the condensation of 12 pounds of steam per hour, corresponding to a reduction of temperature of this vessel when full, of about 3° Fahr. per hour. A 16 hours, overnight period would result in a reduction of less than 50° Fahr. and 180 pounds of steam blown into the reservoir or into its heating pipes would re-establish a temperature of 212° Fah.

ANNOUNCEMENT

The Canadian agency for the firm of Escher Wyss & Co. of Switzerland makers of turbines, both steam and water, has been awarded to the General Supply Co., of Canada Ltd., of Ottawa.

We have received from Cowlishaw Walker & Co. (1920) Ltd., of 14 Cockspur Street, London S.W.I. their catalogue on "Output" Bar Coal Cutters. This catalogue is very well illustrated, and is of interest to those engaged in the task of winning coal.

JAMES MORRISON BRASS MFG. CO.

In the advertisement of the James Morrison Brass Mfg. Co., Limited, appearing in our issue of August 20th, the illustration of the Pressure Gauge Tester was omitted owing to printer's error. On page 15 of this issue this advertisement is repeated showing the illustration.

DIAMOND SPECIALTY CO. NOTICE

In the advertisement for the Diamond Specialty Co. appearing in our issue of September 5th, in many of the copies issued the address "Windsor, Ont.," did not appear, being broken off early in the press run. The name and address in full is: Diamond Specialty Company, Windsor, Ontario.

BOILER TUBE CLEANERS

Editor, Power House.

Will you allow me to make a suggestion regarding a phase of the article first delivered before the engineering section of the National Safety Council at Philadelphia, and re-published in your publication in the issue of July 20?

The author states that, "Rotary Tube Cleaners, motor or turbine driven, are the only mechanical means for cleaning the interior of tubes of water tube boilers. With curved tubes, the cleaner, in its effort to follow a straight line thru the curved tubes, more or less rapidly wear away the metal of the tube at certain points near the bends and not infrequently the tubes are so thinned by the cleaner that they burst during operation."

There is a method which cleans water tube boilers more thoroughly than cleaners of the grinding type can possibly clean them, and has a decided advantage when cleaning the bends of curved tubes. I refer to the vibratory method. This has long been known to be the logical method for cleaning return tubular boilers, but a great many are not aware that it is equally effective in water tube boilers. Vibration absolutely separates scale from metal, and furthermore, in curved tubes, the oscillating pendulum of the cleaner reaches and cleans every inch of the bends of curved tubes, regardless of shortness of the curves, and without the possibility of grinding away any of the metal tube.

Yours truly,
Geo. Farrow

The Sarco Company Inc., New York City, are issuing a bulletin descriptive of their new type E radiator trap, for vacuum, vapor, and low pressure heating systems. The trap operates with a corrugated tube filled with volatile liquid, on the same principle as the traps made by this company for so long. The body of the trap is of heavy cast brass, and the whole construction is rugged and well suited for the purpose it is made for.

Overhauling and Adjusting in the Engine Room

In This Article We Have Gone Into the Question of Systematizing the Ordinary Works of the Engine Room, and Show Some Methods of Keeping Records and Standard Information

By "FITTER"

A NUMBER of different styles of pumps have been discussed, sufficient we think, to make the general principle on which they are designed familiar to those who are interested in these articles. A little has been said in regard to their maintenance and repair, and before we proceed to other engine room apparatus, some few hints will be given on systematising the work of overhauling. By the taking of a little preliminary trouble, much time and material can be saved, to the mutual advantage of the engineer and his employer.

We have spoken before of the lockers or cupboards found in some plants, which contain all kinds of packing, in odd lengths, unsuitable sizes and short ends no use for anything. These all represent money wasted, and also time wasted which might have been spent in recreation to much better purpose. A cupboard such as this represents culpable carelessness, perhaps not on the part of the man actually in charge at the moment, but on his predecessors. These long and short lengths of various brands of packings sometimes represent the art of some supply salesman, who has persuaded the engineer to try his goods, and has sold him a great deal more than was necessary for a trial, with the result that the majority of it is wasted. If you want to try a new packing, get just enough to pack one stuffing box once, and if it is properly paced that's all you need for a trial. If the salesman won't supply any less than enough for two or three fillings, stick to what you have. We believe that nowadays the engineering supply salesman in general is more conscientious than he once was, and will not try to take advantage of a man who is an easy buyer but there were a large number of salesmen who got themselves and their employers a bad reputation in the past, through these methods.

The Right Way

In the small plant there are not many rods and glands to pack, but still there are sufficient to make a good deal of waste possible if care is not exercised. If the man learns to be careful and systematic in the operation of his first small plant, he will not forget these characteristics when he achieves the largest plant and greater responsibility, and he will have cause to bless his early training.

Let us take a typical small plant containing a Corliss engine, a boiler feed pump, a general service pump, and an Underwriter type fire pump. There are a great number of plants of just about this type. Now let us see what we have in the way of packing in these units. Take the main engine first. There are the piston rod stuffing box, and four valve spindle stuffing boxes. Suppose that the boiler feed pump is of the outside packed duplex type. On this pump we shall have four glands on the plungers, two glands on the piston rods, and two glands on the valve spindles. The general service pump will be of the piston type inside packed. We will have then the piston packing, the two stuffing boxes on steam and water ends, and the valve spindle gland, and if the pump is a duplex we can multiply these by two. The underwriter fire pump will have two packed water pistons, two water and two steam rods to be packed, and two valve spindles to be packed. Without considering any small glands for the moment let us see what we have on these pumps and engine alone.

Allowing the general service pump to be a duplex, here we have in the small plant no less than 29 places that have to be packed. In these 29 places, there are 13 different sizes of packing required, and there will be two different types, one being for water, and one for steam.

Ring or Coil

Now it will be best to decide whether we wish to use packing cut to the size of the rod in ring form, or buy it in spiral coils, by the box. In either case we pay for the actual weight of packing we buy, but buying it in rings, we pay a little more, to cover the factory cost of making the rings. For rods under two inches diameter, there is no doubt that the ring form is the more economical. It is easier to handle as it can be slipped

ENGINE ROOM LOG SHEET

WEEK ENDING SEPT 13-1921

BOILERS

	Cut In	Cut Out	Days Run	Cleaned	Repairs To Boilers
No 1	Aug 1st	—	43	Aug 30th	New nipple on shell for feed pipe No 1 Boiler
No 2	Aug 1st	Aug 31st	30	Aug 15th	

ENGINES — Hours Run

Date	7	8	9	10	11	12	13	Total
No 1	0	10	10	10	10	10	5	55
No 2	0	3	3	3	3	3	3	18

GENERATORS — Av. Load Amperes

Date	7	8	9	10	11	12	13	Kilowatts per week: Av Load × hrs × volts
No 1	0	100	90	100	110	100	40	98·3 × 55 × 100 = 540.6
No 2	0	50	45	60	50	80	40	54 × 18 × 100 = 97.2

PUMPS

Date	7	8	9	10	11	12	13	Total
Feed Pump	24	24	24	24	24	24	24	168
General Do	10	10	10	10	10	10	10	70
Fire Do	3	0	0	0	0	0	4	7

Pump Repairs.

Feed Pump Plungers completely repacked Septr 3rd

General Service Pump Piston Packed Septr 5th

Engine Repairs

Piston overhauled, and top and bottom ends tightened up Septr 3rd

Remarks

Neck bush in engine stuffing box worn 1/32" on bottom.

COAL

On Hand at Last Report	Received	Consumed	On Hand	Remarks
70000 lbs.	10000 lbs	28000 lbs	52000 lbs	Fair Quality

Log sheet for small plant.

round the rod, and pressed into the stuffing box with a great deal of ease. Then again, where the width of the stuffing box is large in comparison to its diameter, it is a difficult matter to bend the packing round the rod if in coil form, and cut it to the right length without considerable waste. On small rods such as valve spindles, the ring form cannot be beaten. When we come to the large rods such as the piston rod of the main engine, it becomes a matter of choice but even here we give the preference to the ring form. Large size packing in the spiral form comes in boxes as a rule, and there is always a certain amount of waste. If packing can be obtained in lengths that will cut up evenly, without leaving half or three quarters of a turn to be thrown away, it is perhaps better to buy it in that form.

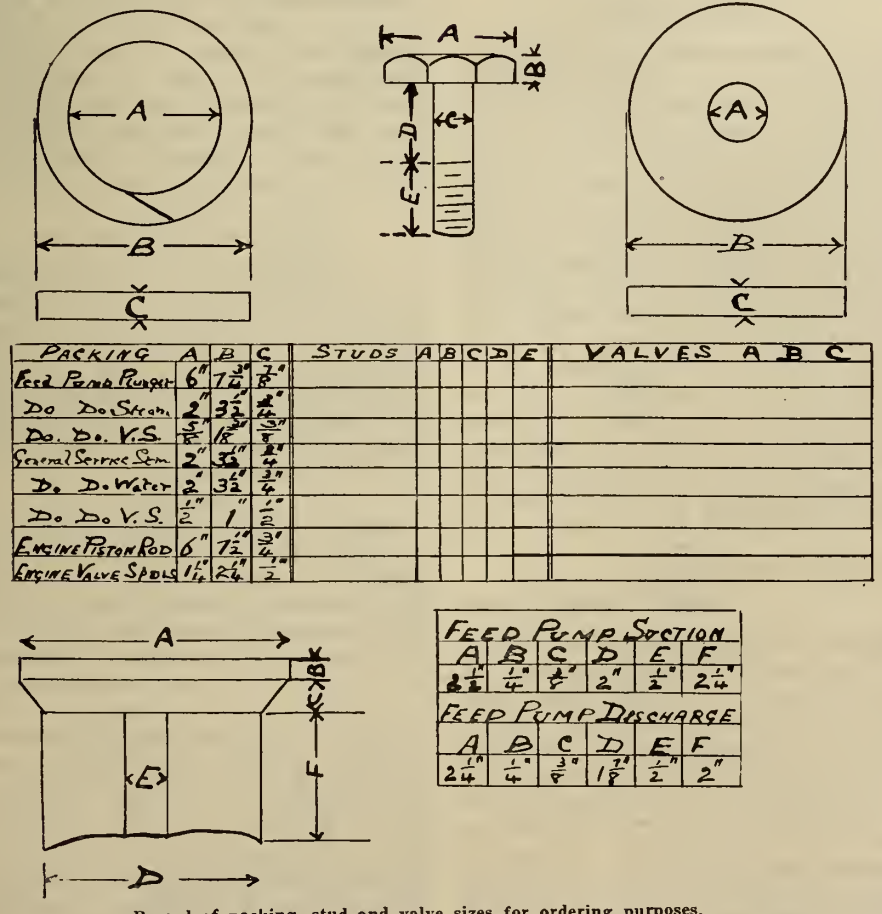
We may say that in this particular case, ring packing will be bought for the small rods, that is the steam rods, and coil packing for the main piston rod. Then comes the question of water ends and pistons. Here the engineer will have to use his judgement again. For the plungers of the outside packed feed pump he will require a packing that will stand hot water, will possess lubricating qualities, and at the same time have good physical strength to uphold the weight and friction of the plungers. It is not our intention to bring down the wrath of rival packing manufacturers on our heads by picking out one or other brand, but just to mention what characteristics are required to obtain satisfaction. There are any number of packings on the market which come up to this specification and it is for the individual engineer to find the one that gives him the best wear without injury to rods, and a minimum amount of loss by leakage. These things are more than first cost, and in considering packings any other material, do not be influenced by price alone. As a matter of fact there is little difference between standard packings in the matter of price.

For the packing of water pistons a packing that will not absorb much moisture, and possesses a good deal of flexibility, with strength is what is required. That means any good fibre packing. The actual wear on this packing due to the weight and friction of the piston is not as much as on the packing in the outside packed pump, owing to the greater area it is distributed over. We have now got three types of packing, to be bought in the various sizes required.

Now a man may order packings himself direct from the agent or salesman, but very likely he will have to make a requisition to the office, and the purchasing agent will do the buying. If our engineer doesn't know very definitely what he wants, this allows some latitude for the purchasing agent to try his hand, with generally evil results. Therefore, know just what you want and why you want it, and be able to state clearly the reasons.

It is necessary in order to know what size packing to order, and when to order it, to have a record of all different sizes of packing that are in use, and there are right and wrong ways of keeping a record of these sizes. Some men have them chalked on the wall, while others keep them in a pocket book which usually can be understood by the man who owns it and no one else. When he goes to another plant, the next man has to make all the measurements all over again. The best way is to make a blue print, or rather make a tracing from which any number of blue prints can be taken, and then order the packing from the blue print. The illustration shows the method of doing this, and we know of no more satisfactory way. That is all right so far as the ordering for sizes goes. There must be a method of stock keeping, and something in which to keep tabs of the way the material is standing up. In other words, a record must be kept of the amount of packing, valves, etc., used by each unit, and the length of time between each repacking or renewing of valves or any other repair that may be made. These should be shown on the weekly log sheet and also transferred to a book or looseleaf system in which each unit is shown separately. This may seem like a lot of work, but in reality the whole thing doesn't amount to five minutes work a week, and the record is well worth while. Suppose you have a pump which is giving a lot of trouble, and you want to have it thoroughly repaired, or better still, replaced by a more economical unit. If you have kept a record of time and material spent in repairing that unit, which record should also contain the actual time it is out of operation, you have got a very good argument to put up to the management. Of course in large plants, these things are compulsory, but there is no reason why they shouldn't be done in the small plant. When the engineer of any plant, however small, can go to his employer and show him in black and white where the money is being spent or saved, the employer is going to look on that man as something more than a laborer, and is going to be more willing to discuss necessary improvements and instruments in the power house.

When you have a record of just when a rod was packed, and how long it usually runs between packing, you don't have to wait till the gland starts blowing badly and perhaps have to shut down to pack it. Your record will show you when to take an opportunity to repack the pump, and if the outside rings are good when you take them out, you may use them again putting the new rings in the bottom of the box, and making a note of just how much new and how much old there is in the stuffing box. If you don't care about using any packing over again, let the rod run till it shows unmistaable signs of needing attention, and then repack it completely. Your work will be lightened, and the upkeep of the plant will be less, and rods



PACKING	A	B	C
Feed Pump Plunger	6"	7¼"	⅜"
Do Do. Stem	2"	3½"	⅜"
Do. Do. V.S.	⅝"	1⅝"	⅝"
General Service Stm.	2"	3½"	¼"
Do. Do. Water	2"	3½"	¾"
Do Do V.S.	½"	1"	½"
Engine Piston Rod	6"	7½"	¾"
Engine Valve Spools	1¼"	2¼"	½"

STUDS	A	B	C	D	E

VALVES	A	B	C

FEED PUMP SUCTION					
A	B	C	D	E	F
2½"	¼"	⅝"	2"	½"	2¼"

FEED PUMP DISCHARGE					
A	B	C	D	E	F
2¼"	¼"	⅜"	1⅞"	½"	2"

Record of packing, stud and valve sizes for ordering purposes.

in better condition if packing is renewed under a definite system. If certain rods require renewing more often than others ascertain the cause, because rods in the same kind of service if in good condition, should run the same length of time. Glands which are not difficult to keep tight, are often through that reason neglected, and it is only when too late that damage is discovered. The valve spindles of Corliss engines, especially on the exhaust side, are very often scored and worn oval simply because they haven't leaked, and the packing has been allowed to get hard, and injure the spindle. Valve spindles on steam pumps are very often left to run with packing that has become hard and because they do not leak very much, are not bothered with. The result is badly worn spindles. The spindle is worn out for the sake of a bit of time and trouble in packing, and a good deal more time and expense is necessary in order to renew the spindle. Hard packing in the water end of a pump rod is a frequent source of scored rods, and these glands should be well looked after. A leak all round one of these glands is much better for the rod than a leak in one spot. A small stream of water continually spurting from one spot in a gland will soon make a deep score in a rod, and especially in a brass rod. A gland evenly packed, and not too tight, with packing renewed before it gets hard, is the best safeguard against scored rods. When a rod does get scored it should be turned up immediately, as it is only waste of packing and time to try and run a badly scored rod.

Keeping Tabs on Valves

The various valves needed on the different pumps should also be carefully tabulated for size, and the length of time that they last. The springs and studs should also be recorded so that they can be ordered when necessary without taking off the cover of the pump to get a sample. When going into a plant where this has not been done previously, opportunity should be taken whenever a pump is opened up to get a sketch of the valves and studs. If there is a drafting office in the plant, get the draughtsman to make a proper dimensioned drawing from which a tracing and eventually blue prints can be made. The tracing is then kept on file and blue prints made when necessary. If there is no drawing office, make a tracing yourself, from which you can get blue prints made with the expenditure of a few cents. No plant is too small to have these blue prints, and the little bit of trouble involved is amply repaid by the saving in time and accuracy obtained.

The accompanying illustrations show the kind of records that may be made and of course they can be adapted to the needs of individual plants.

SELECTING PROPER LUBRICANT

"In deciding upon the proper lubricant many factors enter in of which the average engineer has but very meagre knowledge. Oil for one purpose must have certain qualities and must undergo a certain test. This same test for an oil of different character may be absolutely useless as far as proving anything goes. It does, then, become especially desirous to arrive at some standard way of testing oil.

"The governing feature in choosing the proper lubricant," continues W. J. Bitterlich in a recent issue of Factory, "is its film-forming properties under different load conditions. In general, the lighter the oil that forms the proper film for the load pressure, the lower the friction will be.

"The simplest test of all is with the thermometer. The higher temperature of the oil in bearing shows the greater friction loss. This, of course, necessitates experimenting with at least 1,000 or more different oils in every bearing in the plant, which is rather out of the question for many concerns. However, in this particular plant, where the oil bill amounts to $10,000 or more a year, this method shows substantial saving in power consumption and maintenance.

"The question of light and heavy oils may be settled by noting the amount of waste through stuffing boxes and felt washers. Too light an oil will leak excessively. If an oil is exceedingly heavy, however, too much power will be required to start the machinery when the oil is cold."

These two simple tests will prove good guides for the layman in the selecting of proper oils.

EDUCATIONAL

The classes in Power Plant Engineering at the Central Technical School for the session 1921-1922 will be started on October 1. Registration is now open. This year an initial fee of $3 will be charged, and of this $2 will be returned to those students making the required number of attendances. The first year class will be under the instruction of Mr. M. B. Watson, Director of Engineering, Central Technical School, and the second year class under Mr. T. H. Fenner, Editor of Power House.

The classes will specialize on the necessary work for the Ontario certificates, paying special attention to fundamental principles, and engineers in the city are strongly advised to avail themselves of the opportunity these classes afford.

LOSS OF HEAT FROM BARE STEAM PIPES

FOR bare steam pipes this loss may be taken as 2.7 B. t. u. per hour per square foot of surface per degree Fahrenheit difference between the temperatures of the steam and the outside air. Thus, if the pressure of the steam is 120 pounds absolute, the corresponding temperature being 341°, and the temperature of the air 60°, then the loss per hour per foot length from a 4-in. steam pipe, the external surface of which is 1.178 square feet per foot of length, will be $1.178 \times (341-60) \times 2.7 = 894$ B. t. u. The corresponding condensation can be found by dividing this heat quantity by the latent heat of steam at the given pressure. In the example given above, the latent heat of steam at 120 pounds pressure, absolute, is 877.2 B. t. u. Therefore the condensation per hour per foot length of pipe is $894 \div 877.2 = 1.02$ pounds. — National Tube Co.

PREVENTING AMMMONIA LEAKAGE

The advantage of permanence, lower cost, and ammonia saving, gained by eliminating joints in ammonia pipe coils by Thermit welding as compared with installing ammonia flanged connections is being appreciated according to reports by the Linde Canadian Refrigeration Company, Montreal, Que., which handles refrigeration machinery for industrial plants and ships.

Since adopting this pipe welding process in 1918, the company has ordered material for welding in the neighborhood of fifteen miles of 1¼ inch extra heavy steel and wrought iron pipe for refrigeration units installed in a large number of industrial plants. The length of coil used varies from 500 to 5,000 feet. The whole coil is made up in sections of endless pipe. These sections are flanged and bolted together on the job. The sizes of the sections vary from 6 feet to 36 feet in length, and from 3 pipes high to 20 pipes high. There is one weld for every 20 feet of pipe used. No screwed fittings are used on any of these installations, but instead the pipe is bent to suit, and male and female flanges are connected together using a lead gasket. The coils are flanged before being shipped and tested to at least 150 pounds hydrostatic pressure test. In very few cases has it been found necessary to cut out a weld.

NEW PAPER MACHINES

The Laurentide Co., at Grand Mere, Que., have recently installed two new 166-in. news machines. This means that they will be able to produce marketable paper at the rate of at least 1,000 feet per minute. The machines have a daily capacity of 75 tons each, and were made in Canada. The Dominion Bridge Co., built these machines.

Steam pressures have advanced very rapidly, and in this direction Britain is ahead of America. Two hundred and fifty pounds is quite common, several boilers are working at 350 lb., and in one case at 475 lb. pressure. Evidence so far collected is that maintenance is not greater on boilers working at 350 lb. pressure than those operating at lower values. Safety, with first-class construction, is not a matter of pressure, and an explosion on a plant working at 500 lb. would be little more disastrous than on one operating at 100 lb. Taking into account the present factors of safety, states a well-known authority, conditions are safer in the former case.

WAS THIS A COLLAPSE?

The Editor,
POWER HOUSE
Dear Sir,—

I was much interested in the article entitled "What Pulled the Head In." As a brain exercise it will be alright to attempt a reasoned explanation of the failure without further knowledge and personal inspection, but I doubt if it will end in a satisfactory solution. The front tube plate has very little support against collapse inwardly. It is true that the stay tubes are screwed into the plate and that the long stays may have a nut and washer inside but the plain tubes are only expanded. The expander leaves a taper small and inwards and only initial friction to motion is left. This in an overheated plate might disappear. We cannot therefore consider all the tubes as setting together as one column with a large radius of gyration. If we take each stay tube and stay as a separate column, are they of much use in this way? I don't think so. They can hardly support themselves and unless in tension will have an initial sag in the horizontal position. The flanged edge would become a source of weakness while it was being bent outwards or downwards by the bu'ging shell plate as shown in the photograph, just as the centre of a round lid such as that of a spice tin would be driven upwards if you attempted to flatten out the edge.

Leaving out heavy sediment and only considering water shortage as the cause of overheating it is reasonable to suppose that the end plate near the brick work also became overheated. The proximity of the brickwork would also tend to keep this part of the end plate in an overheated state longer than the bulged shell plate. Now are we sure that at this stage of the game there was not a partial vacuum formed in this boiler due to the rapid cooling of one kind and another? We would then have an overheated end plate, poorly supported against external pressure with an initial strain and even deformation due to the flanged edge locally following the line of the bulge in the she'l plate and subjected to an external stress greater than internal. It may be that the local flattening of the flanged part did all the damage. Suppose we admit this hypothesis we can still I think claim that external influences caused the collapse using external in its broad sense. The heat was supplied from outside causing the shell plate to bulge downwards thus supplying the force necessary to distort the end plate.

Our correspondent has started the ball rolling, and experiences a wish to hear from others. Our columns are open to all who wish to give an opinion. There is one point on which Mr. McDonald is in error. There are no stay tubes in a horizontal boiler, all the tubes being expanded into the end plate.

THE BEHAVIOUR OF PUMP-VALVES

The results of exhaustive experiments made on six types of valves are summarised in this article, which is abstracted from "Forschungsarbeiten aus dem Gebiete des Ingenieurwesens," No. 233. The author obtained a number of diagrams of the movements of the suction and delivery valves of pumps and of the pressures below the suction valves, in the pump chambers, and above the delivery valves. Particular attention was paid to the intensities of the sounds associated with the opening and closing of the valves. For the suction valves noises occurred on closing, and were soft when the final velocities of the valves were about 3-in. per second, and loud when the velocity exceeded 5-in. per sec. These velocities and the intensities of the blows, increased with increase of spring loads on the valves. The blows of the delivery valves increased with increasing lifts and diminishing spring loads. Rather severe water-hammer blows were delivered against the delivery valves just before they opened. Apparently a vacuum is formed through the closing of the suction valves just before the end of each stroke. These blows on the delivery valves increase in violence with increasing spring loads on the suction valves. Several other details are discussed, including the efficiency of pumps.—L. Krauss ("Ver. deu, Ing.")

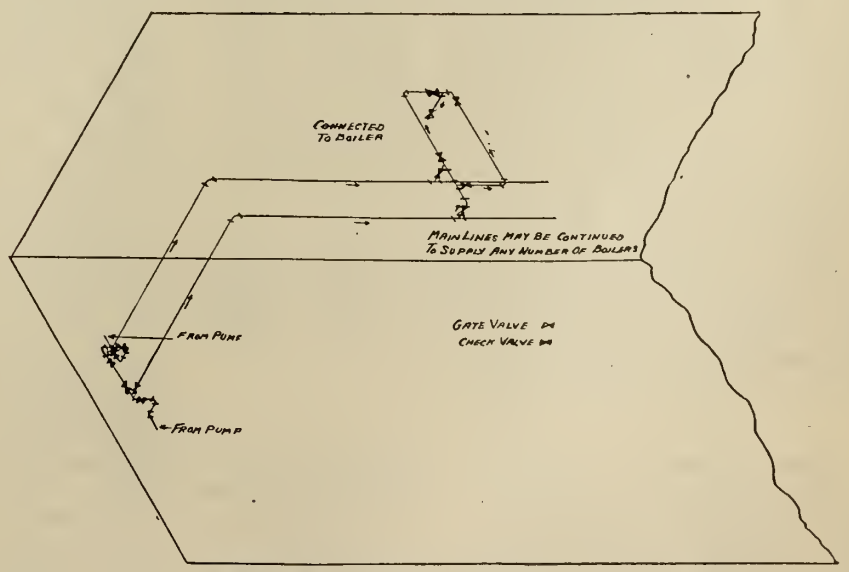
BOILER FEED ARRANGEMENT

By M. C. Allen

Where boilers are operated for twenty-four hours per day and seven days per week, it is necessary when cleaning a boiler to force the others sufficiently to carry the load. In a case like this the feed arrangement should be very carefully planned and laid out so that delays or shut downs shall not occur through inability to supply the boilers with water. These delays may easily arise through faulty valves on the feed line. After experiencing some trouble through causes of the above nature, feed line layout shown in the accompanying sketch was adopted, and the feed water line troubles disappeared.

The system was originally designed to take water from three pumps and so arranged that water could feed from any pump to any boiler and through any part of the line desired. The main lines were carried over the top of the boilers and two branches were connected to each boiler. This gives two check valves for each boiler and allows one to be repaired while the other is in use. Any part of the line may be repaired and the boilers fed through the other line. In the particular installation under consideration a Venturi meter was placed in one pipe line and by this means it was possible to measure the water going into any or all of the boilers and an evaporation test could be made on any boiler at any time desired by feeding that one boiler through the line containing the meter. The valves between the main lines and the various branches were equipped with chain blocks and opened or closed by means of endless chains which came down to within five feet of the boiler room floor. This installation was made on four Stirling boilers and one of the two branches going to the boilers extended about three feet over the side of the boiler to allow a feed water regulator to be installed. After about two years service the line has given no trouble and all repairs or adjustments have been easily made with the boiler under steam. The risers from the pumps were supported on the wall and the horizontal lines were suspended from the roof trusses. There was very little vibration in the line but an air chamber or other cushioning device would probably be found useful to the system.

Catalogue No. 50 just issued by the Julian d'Este Company, Boston, deals with Curtis Engineering Specialties, including pressure regulators, for steam and water, steam traps, damper regulators, relief valves, pump governors and special miscellaneous valves.



Arrangement for boiler feed lines.

Member of the Audit Bureau of Circulation

POWER HOUSE

SEPTEMBER 20th, 1921.

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Is The Law Enforced?

FROM time to time complaints have been reaching us relative to the enforcement or lack of enforcement of the Stationary Engineer's Act in Ontario. In some cases where the information seemed to be definite we have forwarded the complaint to the Board of Examiners, and have received their assurance that an investigation would be made. While many of the complaints have been of a shadowy nature, such as could hardly be acted upon without more definite information, there would seem to be some grounds for dissatisfaction, even if on the principle that there is no smoke without fire. Recently we have heard some very positive statements from men who claimed they could back their statements up with absolute evidence.

We have always taken the attitude, and it is our firm belief that the Board of Stationary Engineers is actuated by absolutely fair motives, and wish to give to every engineer a square deal. We have had no positive evidence to make us rescind that view, but at the same time cannot shut our ears to the undercurrent of dissatisfaction that prevails among a good many reasonable men in stationary engineering circles. It cannot be denied that if the law is not administered with absolute impartiality, and firmness, a huge injustice will be done to the great majority of stationary engineers. Certain standards have been set by the examining board for the different grades, and these standards should be exacted from every candidate who presents himself, without exceptions or favor. Where a plant is of a nature to demand a certain grade of certificate that grade should be insisted upon, no matter who may be inconvenienced in the process. The law is on the statute books, and we have seen how ruthlessly some laws can be administered in this province. While we believe that laws should be administered with a certain amount of humanity and reason, we do also believe in them being administered absolutely impartially. We believe, as we have often stated, that if any case exists where the law is being disobeyed, that it has only to be brought to the attention of the authorities to be remedied. At the same time we think that these authorities have the necessary machinery to become acquainted with these cases without the duty of informing devolving on private citizens.

If any reader of Power House has knowledge of such a case, and can bring properly authenticated evidence to back up his knowledge, we will gladly undertake the task of bringing it to the attention of the Government. It must be understood that rumors and hearsay are of no use for this purpose, facts being the only thing necessary.

The Stationary Engineer's Education

THERE seems to be a great deal of doubt among stationary engineers themselves as to what they need in the way of education, the younger men generally feeling that they want to get practical knowledge instead of theoretical knowledge. This view also seems to prevail among some of the older men, and even at this late date there seems to be an unaccountable aversion to the acquisition of theoretical knowledge. This is the more unaccountable because in almost any walk of life, men are interested in finding out the why of things. The average man looking at a submarine is not content to know that he can submerge, but wants to know something of the reason that makes her capable of submerging and emerging. The work of the engineer who has a knowledge of the principles governing the machinery he operates becomes of vast interest, instead of a mere drudgery. There is nothing more fascinating than acquiring knowledge and when the acquisition of knowledge is necessary to the success of a man in his chosen profession it should be a labor of love. The argument that what a man wants is practical education does not seem to us to be a reasonable one. A man who is employed in a power plant, no matter how humble his occupation, is receiving the very best of practical education, and if he is not benefitting by it, it is his own fault. The writer received his practical education by serving a five years apprenticeship in the first place, and has been continuing it pretty nearly all his subsequent life. Practical education can only be obtained by practice, and we can see no benefit in explaining to a man on a blackboard the proper method of holding a shovel or an oil can, or how to tighten a nut. However, if you show that some man the manner in which the laws of combustion come into play when he uses his shovel, how the laws of friction are affected when he lubricates a journal, or how the effort he puts on the end of his spanner is translated into torsional stress on the stud, then indeed you are opening up a new world to that man. Now before he is in a position to thoroughly grasp these things, he must have a certain fundamental outfit and the principal part of this is a knowledge of the ordinary rules of arithmetic, including fractions, decimal fractions, involution, evolution, mensuration, and enough elementary algebra to understand and use formulae. There is no need for any man to throw up his hands and say he cannot learn these things. It may be difficult, because it is not easy for a grown man to assimilate knowledge as a child does, but the difficulty can easily be surmounted by a little patience on the part of the teacher. The fact cannot be gotten over, that if a man wants to be a success at any branch of engineering, he has got to master these fundamental ideas, and all the practical knowldge in the world will not get him any where without them. No man should be ashamed of the fact that he lacks this knowledge through unavoidable difficulties in early life. That is a misfortune, but not a disgrace, but when a man has the opportunity to overcome the handicap of early years, and deliberately shuts his eyes to it, then he has cause to blame himself. The requirements of the Board of Examiners for a candidate for second or first class as published elsewhere in this issue state very clearly how much mathematical knowledge he needs, and we believe that the earlier a man starts acquiring it the better it will be for him. By the time he is ready to sit for second or first class he should have acquired a practical education of fairly large extent, if he has availed himself of his opportunities and kept his eyes open. Don't be among those who having eyes see not.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

PRINCIPLE OF DYNAMO

Question: — Please explain what causes a motor armature to revolve, when current is supplied to it.

Answer:—This is a somewhat large question to answer in a short space, involving as it does the principles of magnetism and induction. Briefly it may be explained thus. An armature in its simplest form is a coil of wire, placed in the aperture between the north and south poles of a magnet. That is, the coil is in the magnetic field formed by the lines of force passing between the poles of the magnet. If now a current is passed through the coil, a small magnetic field will be induced around the coil itself. Now this magnetic flux will be in part opposed to the lines of force due to the magnet, but in part it will be in the same direction. Where the two fluxes are opposed they neutralise each other, but where they are in the same direction they will help each other. Thus in the diagram the lines of force above the wire are opposed to each other, while those below are helping each other. The result is a tendency to move the line upwards through the magnetic field. This would continue until the conductor was forced out of the strong magnetic field into a neutral point where there was little or no flux and it would stop. However, in the case of an armature which is built up of a large number of coils, when one conductor is passing through the neutral portion of the field, or rather the point of no influx, another group of conductors is passing through the field all of them cutting certain lines of force, so that the action is continuous. Referring to the smaller illustrations. Suppose Fig. 2 is an elementary armature of a generator and suppose it to be moving in the direction indicated by the arrow. The left hand turn moving downwards and cutting the magnetic flux will have an electro-motive force induced in it causing current to flow towards the observer and out through the left hand brush. The right hand wire moving upwards at the same instant has an electro-motive induced in it in the opposite direction or away from the observer. Travelling in this direction the electro-motive-force will cause current to flow around the wire at the rear and down the left hand side of the loop to the left hand brush the same as before, the two conductors thus reinforcing each other and if the circuit exterior to the generator be closed causing a flow of current out the left hand brush through the exterior circuit and back through the right hand one. When the wires due to their rotation reach a point at right angles to that shown or when they are in a vertical position no voltage is generated and no current will flow. In this position the brushes are touching both sectors on the commutator if they be wide enough. Immediately after this position is reached the conductor which formerly was on the right hand side and was moving upwards, begins to move downwards on the left hand side and its end connected to the commutator is put into communication with the left hand brush. Since in moving downwards the electro-motive-force generated was towards the observer, as before a continuous flow of current is set up. The brushes by running on the commutator not only form a path for the current to flow to and from the armature but serve also to give a continuous or uni-directional current. If instead of a split commutator two rings had been installed one for each end of the coil, an alternating current would be delivered, for each side of the loop would have a current flowing in it first one way and then the other as it came under the influence of first one pole and then the other.

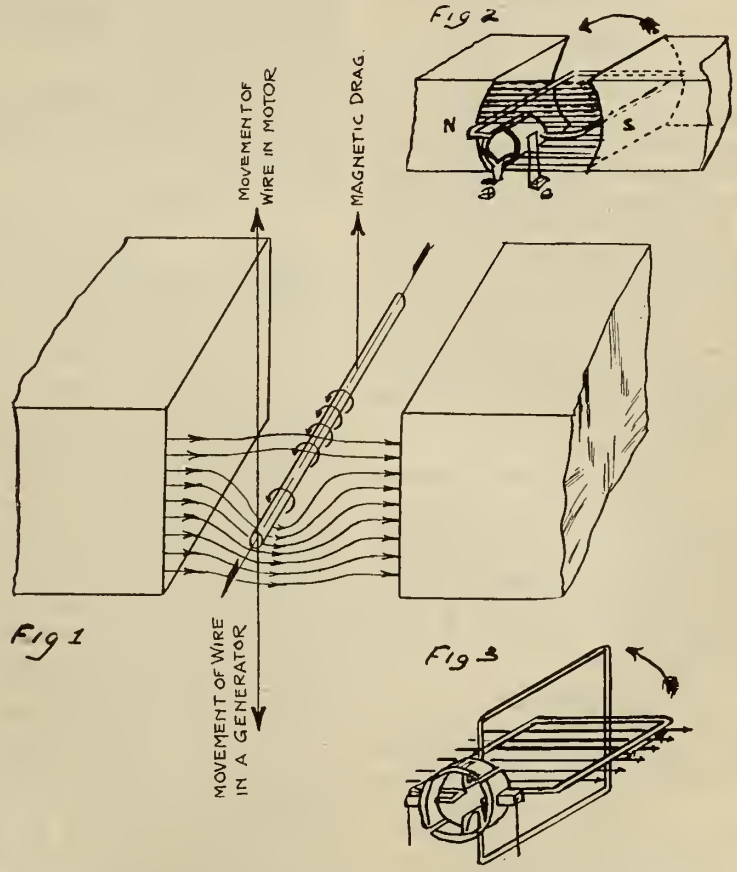

Fig. 1.—Effect of passing current through conductor in magnetic field. Fig. 2.—Single coil elementary dynamo. Fig. 3.—Double coil elementary dynamo.

If two coils of wire similar to the one described be mounted on an axis at right angles to each other with the four terminals of each coil connected to a four part commutator as shown in Fig. 3 then the electro-motive-force generated would be more nearly uniform and in practice commercial machines having a large number of coils, give an almost uniform flow of current, and in the case of motors give an uniform turning moment or torque.

HORSE POWER OF ENGINE

Question:—What is the horse power of an engine and show how to work it out with following particulars? Area of cylinder 341 inches, revolutions per

minute 200, stroke 2 feet, and constant steam on piston 60 lb. per square inch.

Answer:—The horse power is found from the following formula:

$$\frac{P \times L \times A \times N}{33000}$$

where P is mean effective pressure per square inch, L is length of stroke in feet A is area of piston, and N is number of strokes per minute. Substituting figures formula we have

$$\frac{60 \times 2 \times 341 \times 400}{33000} = 496$$

SAVING OF HEAT

QUESTION:—What would be the percentage gained by having a hot water heater with exhaust steam taking the water at 36 degrees Fahrenheit and heating it to 140 degrees F. Show how to find the percentage of gain?

Answer:—The method of finding the percentage of gain in heating feed water is to find the ratio of the heat saved to the total heat in the steam. Supposing the steam is at 150 lbs. pressure per square inch, and a temperature of 366 degrees. Then

$$\frac{T2 - T1}{Ts - T1 \times L} \times 100 = \%\ \text{saving}$$

T2 is the temperature of feed leaving the heater, T1 is the temperature of water entering the heater, and Ts is the temperature of steam in the boiler, L is the latent heat of boiler steam. Substituting figures.

$$\frac{140 - 36}{366 - 36 \times 856.4} \times 100 = 8.7\%$$

Roughly 1 per cent saving of fuel for every 11 degrees water is heated.

AMOUNT OF VACUUM CARRIED

Question:—What is the proper vacuum to carry in a common slide valve engine, cut off at half stroke, and explain why a certain amount is necessary?

Answer:—In ordinary reciprocating engines either simple or compound, though it is usually only in compound engines that condensers are used, the vacuum carried under ordinary circumstances, will be about 25 inches. It is not any advantage to carry any higher than this, and is not practicable. The volume of steam increases rapidly above this amount of vaccum, and it would be necessary to make the low pressure cylinder and its passages very large in order to handle the extra volume, and thus the first cost would be greater than the amount of saving to be gained. If the condenser is of the surface type, and the condensate is used for feed water, a vacuum of 25 inches keeps the water at a suitable temperature, about 125 degrees. Another objection to carrying a high vacuum is the large amount of circulating water needed, which means more work for the circulating pump. In turbine practice it is different, as the gains due to a high vacuum are very large, and the passages ample for the handling of large volumes of steam.

EFFICIENCY OF ENGINE

In the Aug. 20 issue Power House under the above heading, is an answer I do not agree with. In the answer you state that the mechanical efficiency of the engine is probably about 90 per cent. Using the data given and deleting the errors of time, and not stating whether the H.P. given in the question was indicated or otherwise the question becomes:—A steam engine of 120 H.P drives a D.C. generator the capacity of which is 250 amps at 240 Volts. The efficiency of the generator is 88 per cent, what is the efficiency of the engine? My answer is

"The out put of the engine is equal to the brake horse power which is equal to the electrical horse power multiplied by the efficiency or ,

$$\frac{60000 \times .88}{746} = 81.8\ \text{B.H.P.}$$

Output divided by input equals the efficiency of engine. Thus

$$\frac{\times \quad 81.8}{120} = 68\%\ \text{engine efficiency}$$

This engine certainly needs an indicator card taken for valve adjustment etc. Hoping you will show where I am wrong if such is the case. G.A.B.

Our correspondent is in error in so far as he has taken the over all efficiency of engine and generator as the engine efficiency. The efficiency of engine is something entirely distinct from the efficiency of the generator. For instance we might have an engine for the sake of argument which was frictionless, and delivered to the generator shaft the full energy imparted to it by the steam on the piston. In other words we would have an engine of 100 per cent efficiency The generator which this engine is driving might have only 50 per cent efficiency. The efficiency of the whole unit would then be only 50%. Suppose now that our 120 H.P. engine has an efficiency of 90 per cent, (mechanical efficiency). As the generator it is driving is only built to give out 80.40 H.P. the engine would not have to develop anything like 120 H.P. In order to deliver 80.44 H.P. to the generator the engine would have to develop

$$\frac{80.44 \times 100}{90} = 89.37\ \text{H.P.}$$

Now the generator being only 88 per cent efficient, would only deliver at the switchboard $80.44 \times .88 = 70.8$.

Now let us see starting from the engine what we have for over all efficiency

Power put into engine 89.37 H.P.

Power at generator shaft $89.37 \times .9 = 80.4$

Delivered at switchboard $80.4 \times .88 = 70.8$.

Thus we see that the over all efficiency is the efficiency of the engine multiplied by the efficiency of the generator or

$$89.37 \times .9 \times .88. = 70.8$$

To make it absolutely clear if we have an engine of 100 H.P. and a mechanical efficiency of .9 driving a generator with an efficiency of .8 then we get at the switchboard

$$100 \times .9 \times .8 = 72$$

and the over all efficiency is 100×72 or 72 per cent. Thus we see that the engine efficiency has nothing to do with the generator efficiency considered by itself, or vice versa. In the over all efficiency both count.

WORKING OUT CARD

A correspondent sends in a calculation of the indicated horse power of his engine, with a request to correct his calculations where wrong. The particulars he gives are as follows. The engine is a plain slide valve type, cylinder 20 inches diameter and 24 inches stroke, speed 138 revolutions per minute the boiler pressure 95 lbs. per square inch, non-condensing. The result he gets is 498 horse power, and this as he knows is far too high. The error in his calculation consists in having used the boiler pressure instead of the mean effective pressure in making his calculations. The point of cut off is not given, but allowing it to be at half stroke, the mean effective pressure would be approximately 75 lbs. per square inch. The indicated horse power then would be

$$\frac{20 \times 20 \times .7854 \times 75 \times 2 \times 138 \times 2}{33000} = 393.5\ \text{h.p.}$$

If the cut off takes place at 3-8ths stroke instead of half the mean effective pressure then would be approximately, 67 lbs. per sq. in.

$$\frac{20 \times 20 \times .7854 \times 67 \times 2 \times 138 \times 2}{33000} = 347$$

The mean effective pressure is always to be taken when calculating indicated horse power, and is the mean forward pressure minus the mean back pressure on the piston during the stroke.

SAFETY VALVE RING

Question:—Where are the expansion rings in a safety valve and what is their purpose?

Answer:—The ring our correspondent refers to is no doubt the adjustable ring which regulates the opening and closing, or the opening of the safety valve. In order to counteract the effect of the spring compressing, the safety valve is formed with a lip on its edge, which gives it a larger area when open than when closed. On the seat of the valve a ring is screwed, which is capable of being moved up and down. Between the surface of this ring, and the lip of the valve, a chamber is formed known as the huddling chamber. This allows an accumulation of pressure which tends to open the valve further than it would otherwise, and owing to this extra compression the valve closes smartly when the pressure drops. By moving the valve ring up or down, which can be done while the valve is operating, the period of blowing can be made longer or shorter. This ring is found in the type of valve known as pop valves, and is not used in all safe-

(Continued on Page 36)

Variable Speed Motors in Finishing Plants

The Saving In Fuel Resulting From Their Substitution for Independent Steam Drives, As Shown In The Analysis of the Power Problems of a Typical Finishing Plant

By Warren B. Lewis

THE perfecting of the adjustable-speed, direct-current motor has wrought a revolution in the engineering economics of the cotton-cloth-finishing business far greater than would at first appear to be attributable to any advantage which might be derived from the substitution of electric for mechanical drive. Twenty years ago the stationary, constant-speed electric motor found its application principally in small shops or in departments of larger shops where convenience was the predominating factor. A few years later any proposal to substitute electric drive for mechanical drive met with a demand for proof of greater efficiency in transmission, and several years elapsed before prospective purchasers would admit that the use of electric drives would produce economies outside of the field of simple engineering economics.

The adjustable-speed, direct-current motor opened up a field in which mere mechanical efficiency wos not of prime importance, and established a record for productivity that no other variable-speed device could attain. Since that time the adjustable-speed motor has been considered primarily as a variable-speed device which, by reason of its simplicity, perfection of speed control, etc., has outrun all of its competitors. In this paper it is proposed to show that the usually accredited advantages of the adjustable-speed, direct-current motor are not paramount in its selection for driving certain classes of machinery used in the cotton-cloth-finishing business but that it has made possible a reduction in production costs that are most striking.

Nature of Power Problems in Finishing Plants

In the manufacture of cotton cloth the power problems are of the simplest character. In the finishing business, however, they are most complex. Finishing plants use large quantities of power, heat and water, and so great are these as factors of cost that the very location of a finishing plant is determined by proximity to ponds or streams which will furnish millions of gallons a day of clean water, and adequate facilities for the transportation of fuel, greater in weight than the total weight of the product shipped out.

If one takes occasion to visit the many finishing plants in New England (exclusive of those which have in the last few years rebuilt their power plants in accordance with the most modern ideas—and these are very few in number) he will find a great number of small engines, either belted, geared or otherwise connected to machines which operate throughout a considerable range of speed; and one or more large engines exhausting to the atmosphere or running condensing, driving through the usual line and countershafts machines which operate at constant speed. He will find numerous drying machines using steam at pressures of from 5 to 10 lb., individually driven by the before-mentioned small engines, the exhaust steam from which passes into the machines and furnishes the heat for drying. Small engines driving machines which, in themselves, do not require heat, will probably be exhausting into a main which will be connected also with drying cylinders, furnishing the steam which those cylinders require in excess of that furnished by the engine which drives them. He will notice numerous blower systems furnishing hot air for drying purposes; and in many cases the heating coils of these blower systems will be supplied with live steam. He will notice numerous dye tubs, jigs and vats which are periodically filled and emptied; and which, more often than not, are supplied with cold water which has to be heated to the boiling point with live steam.

If he comments at all upon the use of so many small engines, he is sure to be told that the arrangement is a most economical one, inasmuch as all of the exhaust steam from these engines is used in drying processes, and that nothing is to be gained by substituting some drive which uses less steam per horsepower. Having the engineering mind, however, he will speculate on the heat being discharged from the larger engine, either to the atmosphere or to a condenser, and doubt whether the arrangement is as economical as its owner thinks it is. He will at once realize that the actual brake horsepower required for the entire plant does not balance with the heat being discharged from all of the engines, and that there is very evident room for improvement; and he will arrive at the final conclusion that the small engines are justifiable solely as a means of obtaining varying speeds and not as motive power for producing power as a by-product.

In practically every case a survey of the plant will show that the heat exhausted from the main engines is entirely wasted, except for such as may be used in feedwater heaters. Complete analyses of many of these older plants show that from 3 to 5 lb. of coal are used per pound of cloth finished, which indicates at once the importance of the transportation problem and the extent to which the cost of fuel enters into the total cost of finishing.

As far as electric drives are concerned, the constant-speed machines in a finishing plant may be disposed of briefly, as the problem is very simple and varies only in degree from that which applies to any manufacturing process where the power required to drive the machines should cost a minimum. The same arguments apply, such as lower transmission losses, ability to reduce losses to zero when machines are not in operation, ease of control, cleanliness, etc.

If a perfect balance can be maintained between power requirements and the demands for heat, then there is little more to hope for in that particular direction; or, if in the production of power all of the heat units passing away from the engine can be utilized, then also the desired goal has been reached. Again if all the power required can be produced and the heat discharged from the engine be sufficient for process purposes, then the condition is still better because it is always possible to introduce live steam with the least possible loss between the boiler and the point of use. The adjustable-speed motor has not only made this condition possible, but has actually realized it in plants which have become completely electrified.

Variable Speed Devices

The adjustable-speed motor is an ideal speed-changing mechanism. The degree of variation which may be obtained is greater than in any mechanical device, the ease with which the variation may be obtained is ideally simple, and the efficiency is high. Consider it not as a motor, replacing some other form of motive power, but as a speed-changing device introduced between a relatively efficient prime mover and the machine to be driven. Originally designed primarily for machine-tool operation, it was designated as a constant-horsepower motor, inasmuch as it was generally operated at high torque when running at low speed and at low torque when operating at the higher speeds. As a matter of fact, at the lower speeds its rating was somewhat decreased owing to the poorer cooling effect with low armature speeds, and the greater heating of the fields with full voltage applied to them. A four-to-one motor, rated at 10 h.p. between the speeds of 400 and 1600 r.p.m. would perhaps be better rated at 8 h.p. from 400 to 600 r.p.m., and at 10 h.p. from 600 to 1600 r.p.m. at the same temperature rise.

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1 Consulting Engineer, Mem. Am. Soc. M.E.; President Providence Engineering Society.

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As applied to finishing machinery, however, the adjustable-speed motor is more nearly a constant-torque motor. With few exceptions, it is coupled to a machine which requires a fairly definite torque therefore varies with the speed; and if the torque was exactly constant, the horsepower would then vary directly with the speed. This means that the motor operates at its rated horsepower at the highest speed, and at a low horsepower at low speeds. This has both advantages and disadvantages. At the low speed the torque being no greater than at high speed, the reduced armature heating offsets to a certain degree the heating in the fields due to the full field current. On the other hand, at high speeds the armature takes maximum current when the field is weak, which magnifies commutating troubles. The commutating and compensated field motor has practically eliminated this trouble, however, so that these motors will develop full horsepower at the maximum speed continuously and give perfect service.

It has been found that in 90 per cent. of the cases a two-to-one motor will give all of the speed variation that is necessary for general use; while below the normal speed, lower speeds may be obtained for threading up, cleaning, etc., by the use of armature resistance, which by reason of the low horsepower used for so small a proportion of the time, does not affect materially the overall economy of the plant. This makes possible the use of a smaller and more efficient motor for the usual working range.

Note that the losses in an adjustable-speed motor operating under constant-torque conditions decrease nearly proportionately with the horsepower, and then consider this adjustable-speed motor as a device placed between the machine to be driven and the main power unit which will develop a horsepower on about one-third of the steam required by the small engine. Combine the load of all the adjustable-speed motors on to one generating unit, and the result will be a fairly uniform load and practically a uniform steam economy in the prime mover. Compare this with the varying load of the individual small engines in which the heat efficiency is constantly varying, and it requires very little imagination to see where we are being led.

Analysis of a Typical Finishing Plant.

Applying now the general principles set forth in the foregoing to a concrete case, the author will attempt to analyze a finishing plant having a capacity of about three thousand pieces of finished goods per day, two-thirds of which are printed and the other third finished as plain white goods and dyed goods. This is an assumed plant for several reasons; but the principal one is that it is fairly typical from the engineering standpoint.

For the purposes of this paper the equipment of such a plant may be divided into two groups, namely, machines which operate generally at constant speed, and those which operate at varying speeds. The latter being the most important to consider, may be enumerated as follows:

	Max.Hp. of Unit	Max.Hp. of Equip't.
Three singers	6	18
Two mercerizing .. equipments	25	50
Three sets white cans	10	30
Two sets of dyehouse cans	10	20
Six printing machines with their drying cans	30	180
Five complete tentering equipments	12	60
One continuous steamer	20	20
Two aging boxes....	7.5	15
One set starch cans..	15	15
Two open soapers with their drying cans..	30	60
		468

Each of these machines will be driven by variable-speed motive power, i.e., 27 individual steam engines or 27 electric motors, and their total maximum requirements will be, as given in the preceding table, 468 h.p. when operating at their maximum speeds.

Under no circumstances will all of these machines be running at maximum speeds simultaneously, and therefore requiring maximum power. Extensive experience with this class of machinery has proved that the load factor, as it might be termed, is about 50 per cent., and that while any one or even a number of machines may be operating at maximum speeds simultaneously, others will either be operating not at all or at low speeds.

The constant-speed machines in this same plant will require 600 i.hp. if the machines are driven from lineshafts, of which about 50 per cent. will be friction losses. If driven with individual motors, the load will be about 250 kw. This great difference will not be due entirely to the difference between mechanical and electrical losses of transmission, but in great part to the fact that the constant-speed machines will be operated more or less intermittently.

A condition is assumed here which was almost universal up to the advent of the adjustable-speed motor, namely, that the twenty-seven variable-speed machines are driven with twenty-seven small steam engines and the constant-speed machines driven through lineshafting from a simple non-condensing engine. The boiler plant consists of a number of horizontal return tubular boilers, and the average output is 70,000 lb. of steam per hour, about one-third of which is delivered as live steam to processes where high-pressure steam is used.

Condensation in Steam Piping.

There are many hundreds of feet of live and exhaust-steam pipes around this plant, necessitated by the fact that the small engines and process machinery are widely distributed and steam must be delivered to them and exhaust steam taken away from the former. Numerous charts taken from boiler-feed meters will show that the condensation in the steam-piping system will be 10,000 lb. of steam per hour for every hour that steam is on the system, which may and frequently does mean twenty-four hours a day. No material reduction can be made in this loss, except through the removal of all of the piping that is not actually essential to the driving of the machines.

The substitution of the adjustable-speed motor makes it not only possible to eliminate this part of the piping system, but to reduce the sizes of pipes carrying live steam to processes. It is seldom that live steam at a pressure of over 50 lb. is required in the processes; and therefore, with the elimination of the engines, the drop in pressure between the boilers and the processes can be made 50 per cent. or more. Or, still better, the boilers may be divided into two batteries, one group being operated at 150 lb. or more and delivering steam to the main unit and boiler-feed pump, while the other group may be operated at pressures of from 0 lb. down. As a considerable variation of pressure in steam for process purposes is not detrimental, advantage can be taken of the heat stored in the furnaces and in the water within the boilers, so that during periods of heavy drafts the fires will not have to be pushed to maintain steam pressure, while at the slacker periods heat will be stored up.

This has been done in several plants with the result that the evaporation per pound of coal for the group of boilers furnishing live steam for processes has been possible through the introduction of the adjustable-speed motor in place of the small engine.

The heat distribution under the conditions stated may be shown by diagram as in Fig. 1, in which the area of the circle corresponds to a boiler output of 70,000 lb. of steam per hour at 100 lb. gage pressure, feedwater being taken from any source of supply at an average temperature of 100 deg. fahr. and heated to an average temperature of 170 deg. fahr. The question may immediately arise as to why a temperature of 210 or 212 deg. fahr. is not assumed; and the answer is that in practically none of these older finishing plants is the feedwater even heated to a temperature of 170 deg. fahr. This is probably due to the fact that a heater with sufficient surface to raise the temperature of the entire boiler feed from 160 to 210 deg. fahr. would be very large; and with the usual exercise of false economy, heaters of about one-half of the needed capacity are used.

Referring to Fig. 1, the area of the segment A represents the amount of steam which is condensed in the piping system. This figure is taken from actual boiler-feed charts in four plants of approximately the productive capacity of the one that we are considering. The area B is the amount of steam taken by the main engine and is based on 25 lb.

of steam per i.hp.-hr. The area C is the steam delivered to the small engines. The area D is the steam used as live steam in the processes. Segment B is divided to show the amount of heat which is recovered in the feedwater and the heat which is lost. Segment C shows that of 23,000 lb. of steam delivered to the small engines, 20 per cent is entirely lost in condensation, while the remainder may be used for drying purposes.

Steam Requirements for Drying.

The drying operations in this plant will require that each yard of goods be dried three times and will require 1½ lb. of steam per pound of cloth dried. The three thousand pieces will average in weight 10 lb. per piece, and the hourly rate of steam used for drying will be 13,500 lb. From the main engine 10,000 lb. of steam per hour are available, and from the small engine 18,400 lb., a total of 28,400 lb., or more than twice that required. While as a matter of fact it is the exception (rather than the rule) to find a condensing engine doing the constant-speed work, it is apparent that the most economical type of engine would have been the logical thing to have used.

The diagram as presented represents the best condition in that the driers are operating simultaneously with the engines. As a matter of fact, more often than not some of the driers will not be in operation, having completed their day's work before the the end of the working day, or not being in use at all in some of the departments, with the result that the steam exhausted from the small engines will not be reduced in so great a proportion as will the uses of low-pressure steam, and a still greater proportion will be wasted. This is particularly aggravated when the printing department is busy and the dyehouse is not, inasmuch as printing machines always exhaust steam greatly in excess of the requirements in that department.

Segment D of Fig. 1 presents possibilities for some use of low-pressure steam, which, however, were seldom taken advantage of in the older plants, and not always in those which have been rejuvenated. In those processes where it is necessary to heat water up to the boiling point, water may be preheated to a temperature of 160 or 170 deg. fahr. and stored in tanks, from which it may be drawn for use in the dyehouse or in the boiling process. That this has not been done more generally is probably due to the fact that the cost of hot water heating and storage systems is high, and there are difficulties in conveying hot water which are not easily surmounted. It is far better, therefore, to be able to use all of the exhaust steam for direct heating.

This leads up to the general statement that the whole problem of producing power in a finishing plant has been attacked from the wrong end. Analyzed properly, one should first determine the amount of low-pressure steam which can be used economically, and then so design the power plant as to derive all of the power required in the process of producing the low-pressure steam. If it is possible to produce all of the power from the minimum demand of exhaust steam, then the most economical balance will have been attained, because live steam may be introduced through a pressure-reducing valve with practically no loss.

Now for the analysis of this same plant rebuilt in accordance with the statement which has just been made, viz., that the power is to be produced from the steam which can subsequently be passed on to processes with the least loss.

If the plant is to be electrified throughout, the constant-speed motor load will be 250 kw. and the adjustable speed motor load 210 kw. No attempt will be made to discuss the relative merits of a.c. or d.c. generation, this being determined by individual conditions; but for this particular plant it is assumed that a.c. motors are used for the constant-speed work, a motor-generator set to give 230-volt d.c. current for the adjustable-speed work, and a 500-kva. generator which may be either turbine or engine-driven.

The drying operations in this plant require 13,500 lb. of steam per hour at about 5 lb. pressure. The steamer can use 1500 lb. of exhaust steam per hour if it is clean. The two soapers will use 100 gal. of water per minute, which in the old plant has been heated to a temperature of about 170 deg. fahr. by introducing live-steam pipes into the soaper boxes, requiring 5000 lb. of steam per hour. This work can be done with clean exhaust steam, or it can be done in part by collecting all of the condensation from drying cylinders and pumping it into the soaper boxes, instead of back to the boiler-feed heater. This is merely a matter of comparative expense and ease of control.

To heat the feedwater to 210 deg. fahr., 3500 lb. of steam per hour will be required, this figure being derived as follows: The live steam for processes has been reduced from the former requirement of 22,000 lb. to 15,500 lb., requiring that water be taken from an original source and which may be assumed to have an average temperature of 60 deg. fahr. The remainder of the steam (which will be shown later to be 26,000 lb.) will be made from feedwater which has been collected from the various driers at a temperature of 160 deg. fahr., and this being clean water, it can be returned to the boilers.

The total low-pressure steam uses, then, are 23,500 lb. per hour, exclusive of the steam required to heat the buildings, which, taken over a twelve-months' period, may be ignored as far as having any effect upon the design of the power plant.

To operate this plant 460 kw. of electric energy and 23,500 lb. of exhaust steam per hour will be required. A simple, non-condensing, Corliss, releasing-gear engine, direct-connected to a 500-kva. generator will, between the limits of one-half and full load, develop a kilowatt with 42 lb. of steam at 150 lb. initial pressure and 5 lb. back pressure. A 500-kva. steam turbine will operate at the same steam economy.

The turbine has the advantage of giving oil-free exhaust steam. With some precautions the simple non-condensing engine can be used, the chief problem being to remove the oil from the exhaust steam, through the use of properly designed separators. If the plant is already equipped with a good economical reciprocating engine, it would be perfectly good engineering to keep it in service.

To supply 460 kw. at 42 lb. of steam per kw. will require 19,320 lb of steam, and 90 per cent. of this can be delivered to apparatus that can use low-pressure steam at 5 lb. pressure. This will provide slightly less than 17,500 lb. of steam, whereas 23,500 lb. are required. This is a condition which should be very much sought for. If a set of drying cans using a large amount of exhaust steam is stopped for a time, whereas the power required to drive them represents, with the electric drive, comparatively little steam, then there will still be a deficiency

Steam Condensed in Piping System 10000 lbs.
Steam Taken by Main Engine 15000 lbs.
Live Steam Used in Processes 22000 lbs
A
B
C
Steam to Small Engines 23000 lbs.

Diagram showing distribution of steam in Finishing plant.

of exhaust steam in the whole system, and it is always possible to introduce live steam.

The Coal Saving Effected.

In this plant the steam-driven units are confined to one prime mover, and the author would even use a power-driven boiler-feed pump, holding perhaps a steam pump as a reserve unit.

The steam used in this plant, excluding that required for heating buildings, which is a very small amount, totals 43,500 lb.; 23,500 lb. will produce all of the power and low-pressure steam required, 5000 lb. represents condensation, and 15,000 lb. the live steam used direct other than that introduced into the exhaust-steam system. This is a reduction of 26,500 lb. of steam per hour required to operate the plant, and it is easily seen that with an average evaporation of 9 lb. of water per pound of coal over a period of 2700 working hours, this will reduce the coal consumption 4000 tons a year; and this is not the whole of it, by any means.

Finishing plants do not start up at a specified time in the morning and shut

down at a specified time in the afternoon, as do many manufacturing plants. It is the rule rather than the exception that some machines will run overtime, requiring that full steam pressure be maintained on the entire piping system for the benefit perhaps of two or three small engines. It is also the rule rather than the exception that a full steam pressure is maintained on the high-pressure piping-system twenty-four hours a day, with the possible exception of Sundays, entailing excessive condensation losses of more than one-third of the steam which can be accounted for as entering into actual production. With the entire elimination of a large part of the live-pressure steam pipes and a reduction in the sizes of those remaining, not only will the condensation losses be decreased, but it will be possible to shut off the live-steam system entirely when steam at that pressure is not required for high-temperature and boiling operations. Boiling operations carried on at night can be served from a comparatively small live-steam main run directly from the boiler house.

In a certain plant where no printing or dyeing is done, and where the losses through condensation are therefore less than would be found in a plant carrying on all branches of the business, the average boiler load, from 7 o'clock in the morning until 4 o'clock in the afternoon, production being comparatively low, was about 22,000 lb. of steam per hour. For the rest of the twenty-four hours it averaged somewhat more than 8000 lb. per hour. Holiday and Sunday charts in this same plant show about the same amount of water fed to the boilers per hour for the full twenty-four hours. In this case only about one-third of the steam can be accounted for as being directly chargeable to processes.

On another occasion when the plant was somewhat busier, the boiler load was fairly constant at about 30,000 lb. of steam per hour from 7 o'clock in the morning until half past 5 o'clock in the afternoon. From 10 o'clock at night until 6 o'clock in the morning the average rate of feed was 8000 lb. per hour as before.

The maximum boiler load in this particular plant is about 35,000 lb. of steam per hour, so that it is at once apparent that the constant loss of 8000 lb. over twenty-four hour is a very large proportion of the total steam. The remedy for this is to eliminate every foot of pipe which is not absolutely essential and keep steam out of that part of the piping system where it is not needed after the day's work is over.

Influence of Losses on Production Costs

The influence of these constant losses upon the cost of production can be well illustrated by putting production in yards per week against pounds of coal per yard of cloth finished. Such curves make it at once apparent that as the production increases the amount of coal used per yard decreases at a rapid rate, and probably reaches a minimum when the plant is being pushed to its very limit of capacity. The coal in this case represents nearly the entire mechanical costs, exclusive of repairs, viz., power, heat, light, cost of pumping water, drying and boiling operations, and, in fact, everything which ultimately has to be accounted for in the coal pile. While the adjustable-speed motor can hardly be credited with all of the saving which it has been possible to make in finishing plants, its introduction has made the other things simple of accomplishment. Maximum production on any machine must be the offset to rising labor costs. Finishing machines, operated at varying speeds, are subject to many interruptions, and are started and stopped, or slowed down and speeded up, many times a day. With small engines speeds are rather indeterminate. If a set of driers is slowed down and then speeded up again, there is very little assurance that the speed will be brought back to the maximum permissible at the time, because the eye of the operator is the only speedometer available. With the adjustable-speed motor and its predetermined speed push-button controller, the running speed is always returned to one definite speed after a slowdown, and a fair degree of assurance is substituted for guessword.

In some of the processes there are two, and sometimes three, individual machines which have to run in synchronism, the cloth passing through one after the other continuously. With the old mechanical drive the small engine constituted the motive power and the several machines were driven through a series of shafts, bevel gears, pulleys, cone pulleys or Reeves drives, so that the speed could be adjusted to fine limits between the several elements, and then all travel at the same speed.

With the adjustable-speed motor an individual motor can be attached to each element, all operated from one controller, and the speed will be varied uniformly and all elements started and stopped together. This is now the generally accepted method of driving such ranges. If it is desired to operate one element of the range for some particular purpose (as is by no means unusual), then the other motors can be disconnected and the individual machine driven with it own motor.

If the author appears to have been enthusiastic in his presentation of this topic, it is because he has seen the steam consumption of finishing plants reduced to one-half those which previously obtained, and the savings in the cost of fuel pay a very handsome return upon the cost of not only substituting the electric drive but for making all of the other changes in mechanical equipment which could be properly grouped with it.

SAFETY VALVE RINGS

(Continued from Page 32)

ty valves. The amount of extra load due to compression of the spring is in exact ratio to the amount of compression. Thus if a valve is set to blow at 100 lb. per square inch with a spring 6 inches long, and it opens one quarter of an inch the load will be

6 ; 6.25 ; 100 :x 104.16

STEAM PUMP AND FLUE GASES

In the design of a boiler feed pump the ratio of the steam and water cylinders are so arranged that the push on the steam piston is great enough to feed the water into the boiler in a steady stream. The pressure per square inch being the same in the steam and water cylinders. To use steam expansively you would require to increase their ratio so that steam pressure and piston area always dominated water pressure and plunger area. Doing this would not alter (neglecting small losses) the total steam used.

1st case. Steam used at boiler pressure to end of stroke area sq. in. × stroke in. at pressure = Steam used per stroke

2nd. case. Steam cylinder increased to twice the area of 1st case and steam cut off at half stroke.

2 area × stroke at ½ pressure or 2 area × ½ stroke at pressure = same as 1st total.

The speed of your pump would no longer be constant and your pump would cost more. It would also require greater room to house.

As regards second part of this question I do not think there is sufficient information given to discuss same. In a general way if an air leakage increases temperature it would show that there is not sufficient air getting in at the legitimate openings to complete combustion.

TAIL END RODS

The junction of a tail end rod is that of keeping the piston from working on the underside of the cylinder.

To do this successfully for any length of time there has to be added some form of slipper guide and these guides must be kept in perfect alignment with cylinder and crosshead guides.

I have examined a good many old cylinders and have found nothing to encourage the thought that much was gotten in return for the cost of installing the extra guides, rod and gland. There is probably a film of oil and moisture in the bottom of the cylinder sufficient to keep down wear.

The extra gland is a source of waste and the extra floor space often a consideration.

W. B. MACDONALD

We have received from the Dayton Dowd Co., Quincy, Ill., a catalogue describing their centrifugal fire pumps. These pumps are arranged for motor, turbine, or gasoline engine drive. The catalogue is illustrated and shows several views of the pumps themelves and also the plants in which they have been illustrated. Some curves of pump characteristics are also included, and outline diagrams showing space required for installation. The compact arrangement will appeal to factory owners and others to whom space is a consideration.

Combustion and Refrigeration

This Short Paper Given Before the National Association of Refrigerating Engineers, Contains Some Good General Advice on the Subject of Combustion Efficiency

[F given a little latitude we may define combustion as the process of reducing heat. The cycle of events i a refrigerating plant would be interesting, if for no other reason, because in order to get rid of the thing hat we do not want we must first manufacture some more of the very same hing.

There is no special message upon ombustion that can be given to an ssociation of refrigerating engineers. ou want combustion efficiency in your lants for the same reasons that everyody else wants it, viz.: You burn the me kind of fuel that everybody else rns, which may be the fuel best adpted to your furnaces, your boilers, id your load, or it may be whatever el you can get. There are no special signs of boilers and furnaces for refrigerating plants. There are no special lvantages or disadvantages of operaon to be considerated when your plants e compared with those in other lines, less it be the advantage that consists a fairly uniform load and the disadntage that consists of small capacity. he big plant can produce power more eaply than the little one because cost production always depends, to some tent, upon quantity of production.

Combustion is combustion. It is the me chemical action no matter under hat circumstances it may take place. is the rapid chemical union of oxygen ith the combustible, whatever the latr may happen to be. Light and heat e its manifestations.

In order to avoid confusion at the tset in the use of terms let me first fine the distinction that should be ade between the terms complete comstion and efficient combustion.

Combustion is complete when all of e combustible has been totally conmed or converted in the chemical retion—when there is no combustible in e ash and none in the flue gases. ut while complete combustion is an ement of the most efficient combustn it is not a guarantor of combustion ficiency. Combustions may be comete to the last atom of the combuste and there may be very little of the ing that we call combustion efficiency. c combustion may be incomplete and e combustion efficiency may be very od. Many people think that a smokess stack is an evidence of combustion ficiency, whereas it is very often an idence of the contrary.

We burn fuel because it is the most nvenient way we have of putting heat ergy into the active, usable form. ow while we may get all of the heat ergy out of the fuel and into the tive form we may at the same time do something to render a portion of the heat energy non-usable or non-available, just as non-available as it was when it was in the original fuel in the original geological seam, and more so, because the non-available heat of the fuel in the mine may be rendered available by mining and burning, but the heat that is rendered non-available between the furnace and the heating surfaces of the boiler is lost for all purposes and for all time.

Combustion Efficiency

Here we have a boiler. We want to make steam at say 150 pounds boiler pressure the temperature of the contents of the boiler would be right at 366 deg. F. Now suppose that we have complete combustion in the furnace but that we admit a great excess of air, partly through the fuel and partly through the walls of the setting, and that this excess of cold air is sufficient to lower the temperature of the gases by the time they reach the boiler surfaces of 366 degrees. All of the heat resulting from the combustion would be in the gases, but there would be no flow of heat from the gases to the water in the boiler in excess of that from the water to the gases because there would be no temperature difference into induce the flow. This would be an extreme case, of course, but it is in extreme cases that we find the most clairifying illustrations.

What we call combustion efficiency, and it is a purely arbitrary term, depends therefore upon the completeness of combustion and upon what happens to the heat unit on its journey from the fuel to the boiler heating surfaces. If the heat energy is partly nullified by an unnecessary excess of cooling air the combustion efficiency will be lower than if the unnecessary excess is excluded. Excess air is the greatest of all causes of fuel waste and, in some respects, it is the easiest to eradicate of all of the causes of fuel loss.

Excess air is the air that is taken into the furnace or into the boiler passes in excess of the requirements of combustion. Both complete combustion and efficient combustion require some excess of air because it is impossible in practice to provide such an intimate mixture of air and combustible that there will be no excess of either, but in good practice it is not necessary for us to use more than 40 per cent. excess with a good coal fuel.

Much of the troublesome air excess can be eliminated if we are careful to make sure that the boiler setting is free of leaks. When you get back to your plants make a personal examination of the settings. Take a candle and go all over them, trying the candle flame at everything that looks like a crack. If the flame draws in, plug the crack with cotton waste that has been dipped in a thin mixture of fire clay and water, using a sharpened piece of wood for a calking tool. Examine with particular care all places where brickwork and metal joins, as for example doorframes, furnace fronts, arches at the rear of the boiler, etc. Try the candle where the blow-off pipe passes through the brickwork at the rear of the boiler. Usually there is a sleeve about the blow-off pipe to permit movement induced by expansion and contraction. The space between the sleeve and the brick may be filled with cement or any material, but that between the sleeve and the pipe should be packed with some yielding material, such as asbestos rope. After you have finished calking, cover the brickwork with any one of the several plastics on the market. If you would all do these things I would feel safe in guaranteeing an average fuel saving of 10 per cent.

A great excess of air may, and usually does, enter the furnace through the grate. The next time you enter your boiler room open the furnace doors and look at the fires. They should be dazzling white, but if they appear to be in that condition do not assume that no undesirable excess air is passing through them. There may be large holes in the rear of the grate or on the side of the furnace opposite to the observation door. Use a pair of dark glasses when you are looking at the fire. But the chances are that you will not see a dazzling white fire; it may be anything from that down to a bed of smoldering coals. The chances are that you will notice many cracks and air holes in the fuel bed, with, perhaps, bare places here and there. If it is a stoker with inclined grates the fuel is likely to break apart and slide upon the grates, exposing the naked grates. If it is a chain-grate stoker the fuel may burn faster on one part of the grate than on another. An automatic stoker is no guaranty that the furnace will not be guilty of excess air. Some of the most inefficient plants I have ever seen were stoker plants and some of the most efficient were hand-fired plants. While the days of hand-firing are almost over it is not due to the supreme efficiency of automatic stokers. It is due to the larger capacity that can be secured with them, to the saving of labor that they effect and to the general tendency to work toward mechanical devices. The constant deterioration in the quality of

our fuels has something to do with it and the stoker of the future will be the one that will be able to digest anything, which by any sort of courtesy can be called coal.

While on the subject of stokers it is apropos to say that they are not, strictly speaking, devices for small plants. There is a small plant in my own city, hand-fired at present and employing but one fireman. A stoker is being installed. How can that stoker save any labor. It is a mechanical contrivance and subject to breakdowns in addition to ordinary repairs and depreciation. When it breaks down as it may, some day, the plant will be shut down until it is repaired. I have the word of a leading manufacturer of mechanical stokers that it does not pay to install them unless it can be shown that the labor saving will pay for the equipment within three years. The small plant, and the majority of ice refrigeration plants are small ones should give due consideration to all the factors that enter into the equation before purchasing a stoker.

In getting the thing that we call combustion efficiency I suppose that apparatus counts for about 10 per cent. and operation for about 90 per cent. Hence those of us who are thinking about combustion efficiency all day, dreaming about it all night, are giving more study to the human factor than we are to the mechanical equipment. Think of it a moment:

It is estimated that more than one hundred million tons of coal are wasted every year in the United States because we do not give attention to the practices of the boiler room. Multiply one hundred million by the price you are paying per ton of fuel and you will come to the conclusion that the gigantic rat-hole, known as the Emergency Fleet Corporation, has nothing on the boiler rooms of the stationary plants of our country.

It will be impossible owing to the limitations put upon this paper to go into any of the details that must be observed in getting combustion efficiency. I must confine myself to generalities, and I would have to do that more or less in any event, because each plant presents its own details and in solving the detail problems we must rely upon general principles.

The first requisite of combustion efficiency is a steam plant that has been the subject of some thought before it was installed. The plant must fit the work that it is suited to do. The furnaces and boilers must be suited to each other and to the fuel which must be used. The time will come when steam plants will be limited to short-haul fuel in order to relieve tranportation from its unnecessary burdens. The consumer will not be permitted to haul coal from Pennsylvania to Illinois, for example. He will have to burn Illinois coal. Everybody will be forced to burn the fuel that can be laid down at his plant with the minimum of haul. If you are planning a new boiler plant take that into consideration.

Importance of Proper Draft

The fireman must be educated to good practices and we have said a lot when we speak of educating firemen. What do I mean when I speak of educating them? I do not mean that we should undertake to make combustion engineers of firemen. I mean that we should teach them the things that they must know and that we should insist upon their observance that they should observe. This is not difficult, even with the most illiterate firemen.

Draft is a very vital thing in a steam plant and most plants have more of it than they should use, and strange as is may seem most engineers think they have insufficient draft. The draft must be held down to the requirements of efficient combustion, otherwise an excess of air will be pulled through the fire, the gases will pass across the heating surfaces at too high a velocity and the uptake temperature will be too high.

We cannot set the damper in a fixed position and say we now shall have the right draft, because the conditions that produce draft are subject to constant changes. Draft is affected by the wind, by the barometric pressure, and by the temperature of the gases in the chimney. Other secondary circumstances affect it. Your fireman cannot get the best combustion efficiency unless he knows what draft to use and has a gauge to show him at all times what draft he is actually using. A furnace without a draft guage is like a ship without a compass.

With a fair grade of coal the uptake gases should contain from 12 to 15 per cent. CO_2 by volume, and no Co. When such conditions obtain the air excess is within permissible bounds and the combustion efficiency will be satisfactory. A CO_2 recorder, showing the fireman at all times the efficiency that he is getting, and showing you at the end of the day all of the variations in efficiency during the day, is, in my opinion, one of the requisities of the modern plant, especially the plant that is not under the constant supervision of an expert combustion engineer. The chart from such a recorder enables you to compare the efficiency of each fireman with that of every other one and makes it possible for you to keep in the closest sort of touch with what is going on in your boiler room.

Every team plant should keep its daily records, and these should be sufficiently comprehensive to tell the whole story of the boiler room, The records should cover daily coal consumption and daily average CO_2, together with anything else that may have a bearing upon efficiency, such as daily records of the ash weights and if possible, of the daily evaporation. There is danger sometimes, of carrying the record-making too far. Record keeping should not be burdensome. The records should show the essential things and omit the non-essential.

The average steam plant in the United States wastes 25 per cent. of its fuel. Refrigeration plants are not above the average. You can take one-quarter of the money that you are now spending for fuel and throw it into the dividend account, where it will benefit your stockholders rather than the coal dealer. I submit that it is your duty to do so.

HEATING THE STOREROOM

A peculiar case of improvement in heating is told by a writer in the Dodge Idea. He states that the workmen of a certain firm were complaining about the storeroom not being warm enough. Investigation showed ample radiating surface and that the heating system was working as well as could be expected of it. However, the men kept complaining about it being cold in the passage way between the shelves, which extended up to the ceiling. In the open places it was comfortable.

It was decided that the fault lay in the solid partitions. As a remedy it was suggested that they remove the solid partitions and substitute expanded sheet metal which would allow a free circulation of air. After the change was made there were no more complaints about a cold store room.

In an article by Mr. Daniel Wilson appearing in the Electrician, on "Steam Raising, Yesterday, To-day and To-morrow," it is stated that thirty years ago the maximum steam capacity of boilers was about 7,500 lb. per hour; to-day 130,000 lb.. of steam per hour is attained. America has led the way in large boilers. Engineers in this country prefer distribution in several units. Moderate sizes of 20,000 lb. to 30,000 lb. per hour have been usual, but recently 50,000 lb. to 80,000 lb. units have become common, and boilers for 100,000 lb. per hour (actual) are under construction for the Manchester Corporation. The size of boiler has little effect on unit thermal efficiency. Thus, Detroit Station has an overall thermal efficiency of 16.5 per cent. with 130,000 lb. per hour boilers; in this country 80 per cent. is reached with boilers of moderate size evaporating 30,000 lb. per hour.

The Yarnall Waring Co. of Philadelphia have issued a bulletin describing their Yarway Double Tightening Valves which are suitable for use on acid lines, soot blowing systems, locomotive service and pneumatic systems, in addition to their use as blow off valves The pamphlet is entitled "Tight in Tough Places."

Stationary Engineers' Examinations

We have received so many enquiries from engineers who wish to know the requirements of the Stationary Engineer's Board that we are again printing this information as issued from the Board's offices.

Hoisting Engineer

Mathematics

A knowledge of arithmetic sufficient to solve any simple problem involving multiplication and division:

Boilers

A general knowledge of all types of boilers, dealing particularly with vertical and locomotive types; a knowledge of how and where boilers are stayed; how and where tubes are fastened in place; where manholes and handholes are placed and how plates are held in place; a thorough knowledge of the care and upkeep of safety valves, water columns, water glasses, steam gauges, blow-off valves, etc., together with a knowledge of the cleaning of boilers:

Injectors

A thorough working knowledge of the construction, care and upkeep of injectors, together with a knowledge of how they are connected up and the piping and valves that should be used in connection with them; a knowledge of the conditions under which injectors will operate:

Pumps

A general knowledge of the different types of pumps, both centrifugal and reciprocating:

Engines

A thorough knowledge of the plain slide valve engine; a knowledge of how to set the valves, replace piston rings, together with a knowledge of how to do general repair work on all parts of the engine; a knowledge of how to set eccentrics on reversing engines:

Lifting Gear

A knowledge of the construction and operation of drums, clutches, brakes, pulleys, etc., a knowledge of the sizes of cables, chains, and ropes required to lift certain loads and the power gained by double and triple blocks:

Derricks

A knowledge of the construction of the different kinds of derricks, gin poles, guys, etc., together with a practical knowledge of levers, incline planes, also to possess sufficient knowledge to answer in a practical way what strains would be placed on a boom when at different angles when lifting certain loads:

Combustion

A knowledge of the best methods of burning fuel:

Third Class Engineer

Coal

A general knowledge of the composition of coal, togther with a knowledge of the handling of same:

Combustion

A practical knowledge of combustion; a practical knowledge of hand firing, and a mechanical knowledge of underfeed and over feed stokers:

Boilers

A general knowledge of the construction of all types of boilers; a knowledge of the parts stayed and why such parts are stayed; a thorough knowledge of the care and upkeep of stays, tubes, handhole and manhole joints, fusible plugs, and methods of cleaning and keeping clean all parts of a boiler; a thorough knowledge of the construction and action of safety valves, water columns, blow-off valves, and all accessories connected with boilers:

Boiler Setting

A knowledge of the method of keeping brickwork in good repair:

Piping

A knowledge of the method of keeping pipe-work in good repair:

Steam Engine

A knowledge of the method of setting valves of steam pumps and slide valve engines; a knowledge of the method of proper lubrication and general upkeep of engines:

Steam Turbine

A general knowledge of the lubricating system, governors and throttle valves of steam turbines:

Condensors

A general knowledge of different types of condensors, and where, how, and why they are used; a knowledge of the general care and upkeep of condensor auxiliaries:

Auxiliaries

A general knowledge of the different methods and apparatus used for heating feed water; a general knowledge of why feed water is heated:

Electrical Equipment

A knowledge of the method of operating an ordinary upkeep of generators, motors, etc., together with an elementary knowledge of electricity:

Oils

A general knowledge of the qualities of oils together with the method of treating same:

Heating and Ventilation

A general knowledge of the different methods of heating and ventilating buildings:

Hydrostatics

A thorough knowledge of the construction, operation and care of injectors, boiler feed pumps, and other apparatus used in supplying water to boilers; a general knowledge of pumps used for purposes other than feeding boilers:

Miscellaneous

A knowledge sufficient to give an intelligent answer to any question relating to the uses, care, and operation of throttle valves, non-return valves, steam separators, steam traps, expansion joints, reducing valves, sight feed lubricators, pump lubrication, or any other apparatus commonly used in an ordinary steam plant:

Refrigeration

A general knowledge of the machinery used in ice making:

Water Softening

A general knowledge of the impurities found in water, their effcts on boilers, and method of counteracting them:

Mathematics

A sufficient knowledge of arithmetic to enable him to work problems involving multiplication and division.

First and Second Class Engineer

Coal

A knowledge of the composition, storage, and care of fuel; different grades and heating qualities in same, (togeth-

er with a theoretical knowledge of how the heating qualities of coal are measured):

Ash and Coal Handling Apparatus

A knowledge of the different methods and apparatus used in handling coal and ashes:

Combustion

A theoretical as well as practical knowledge of combustion, together with a working knowledge of CO_2 machines, draught gauges and all other instruments used in testing furnaces underfeed and overfeed stokers, including air ducts, etc.

Boilers

A knowledge of the construction of all types of boilers; a knowledge of how to figure the strength of boiler heads, shells, stays, etc., and to compute the efficienty of boiler joints compared with solid plate; a knowledge of the method of conducting hydrostatic and hammer test of boiler; also, to be able to define terms such as "Bursting Pressure," "Working Pressure," "Factor of Safety," "Tensile Strength," etc.; a knowledge of the method of conducting efficiency test of boilers; a thorough knowledge of all safety and other devices used in connection with boilers:

Boiler Settings

A knowledge of the construction of Dutch ovens, arches, bafflings, and all brickwork in general, including flues, chimneys, etc.:

Piping

A knowledge of the size of piping to be used; a knowledge of the theory and practice of expansion joints, steam separators, steam traps, non-return valves, reducing valves, flow-meters, calorimeters, thermometers, etc.:

Steam Engines

A knowledge of all types of valves and how to set them, (together with a theoretical knowledge of the different types of governors, including safety stop devices; a knowledge of how to figure the horsepower (and steam consumption from an indicator card,) and correct any defect in the setting of the valves; a knowledge of compound and triple expansion engines; a thorough working knowledge of the steam tables, and action of centrifugal force; (a knowledge of the Zeuner or Belgram valve diagram:)

Steam Turbine

A knowledge of the principle upon which turbines are able to convert heat energy into mechanical energy and to be able to describe the bearings, oiling system, governors and auxiliaries used with turbines:

Condensors

A knowledge of the construction of the different types of condensors, together with a knowledge of their auxiliaries and the (theoretical) advantages gained by the use of condensors on different types of engines and turbines:

Auxiliaries

A knowledge of the construction of different types of feed water heaters and economizers, and a (theoretical) knowledge of the precentage gain to boilers in having feed water heated:

Refrigeration

A knowledge of all types of machines used in the compression of air and ammonia, and all auxiliaries connected therewith; also, be familiar with the use of tables of vaporization of gas and be able to explain the theory of refrigeration:

Electrical Equipment

A general knowledge of the care and operation of generators, motors, transformers, switchboards, and house and factory wiring, together with an elementary knowledge of electricity, including meter reading:

Oils

A knowledge of the ingredients and qualities of oils, together with a knowledge of apparatus used in the treating of same:

Heating and Ventilation

A knowledge of the different methods and apparatus used in heating and ventilating buildings:

Water Softening

A knowledge of the different impurities found in water, together with their effect on boilers, and a knowledge of chemicals, apparatus, and methods used for softening water:

Hydrostatics

A knowledge of injectors, pumps, lifts, and all other mechanism used for handling liquids, or propelled by same:

Mathematics

A thorough knowledge of fractions, decimals and square root, and solution of any algebraic equation with one unknown; a knowledge of the method of finding the area of a circle (of segment of a circle,) and the volume of a cylinder, and be acquainted with the relation of the sides of right angle triangles to one another; (a general knowledge of the method of the theory of the parallogram of forces;) a knowledge of the method of figuring problems relating to a chain of gears, rope blocks, incline planes, levers, etc.:

Blue Prints

A knowledge of the reading of blue prints, and the ability to make a working sketch of any point of any apparatus.

The American Engineering Company have issued two new booklets dealing with the Taylor stoker. The first one is entitled "To-day's Problems and the Taylor Stoker" and deals in detail with the construction and operation of the stoker, with plenty of illustrations. The second one is entitled "The Central Station and the Taylor Stoker" and deals as its title implies with the installation of these stokers in large central plants. Another interesting little pamphlet is called "I See a Power Station" and contains a very well written account of a sudden storm and its effect on the load in a central station. These three booklets are an interesting addition to the literature on mechanical stokers.

Toronto—Tenders for the construction of the new east-end branch Technical High School, totalling $771,593, were approved at yesterday's meeting of the advisory industrial committee of the board of education. This figure marks a reduction of twenty-five thousand dollars on the total of the tenders rejected earlier in the Summer. A bulk tender of $607,192 was awarded to Witchell and Sons for twelve trades including masonry, stone, steel, carpentry, roofing, plastering, etc. Plumbing, heating, heat regulation and refrigeration were lumped, being allotted to W. G. Edge Company for $117,000. The next lowest figure for the whole building made up of tenders on individual trades, totalled $780,165. The new school will have a front center section of three storeys, with a wing one storey high to the rear. It will be of fireproof construction throughout and will accommodate approximately 1,000 day pupils and 2,500 night pupils.

Employees of General Motors in Oshawa now number about 1,350. There is not much likelihood that this will be increased in the immediate future, but hopes are entertained that the working force will be enlarged within a few months.

CARELESSNESS

"I am not much of a mathematician," says Carelessness, "but I can add to your troubles, I can subtract from your earnings, can multiply your aches and pains, I can take interest from your work and discount your chances for safety. Besides this, I can divide your thoughts between business and pleasure and be a potent factor in your failures. Even if I am with you only a small fraction of the time, I can lessen your chances for success. I am a figure to be reckoned with. Cancel me from your habits and it will add to your total happiness."—Paron.

Speed, Safety and Durability

These are the characteristics of YALE SPUR GEARED CHAIN BLOCKS that make them popular in machine shops.

Big fellows for placing machinery in position and little fellows swung from jibs for feeding the machines, are all made on the same high standard. With a continuous hand chain guide, the hand chain won't gag or foul from side pull or high speed.

YALE blocks will give you service.

Brownhoist Steel Plate Trolleys either plain or geared should be used with a YALE chain block.

Small sizes with bronze bearings, two ton and over with roller bearings and with four wheels set at the correct angle. An easy running, safe, durable trolley and fit to be used with YALE chain blocks.

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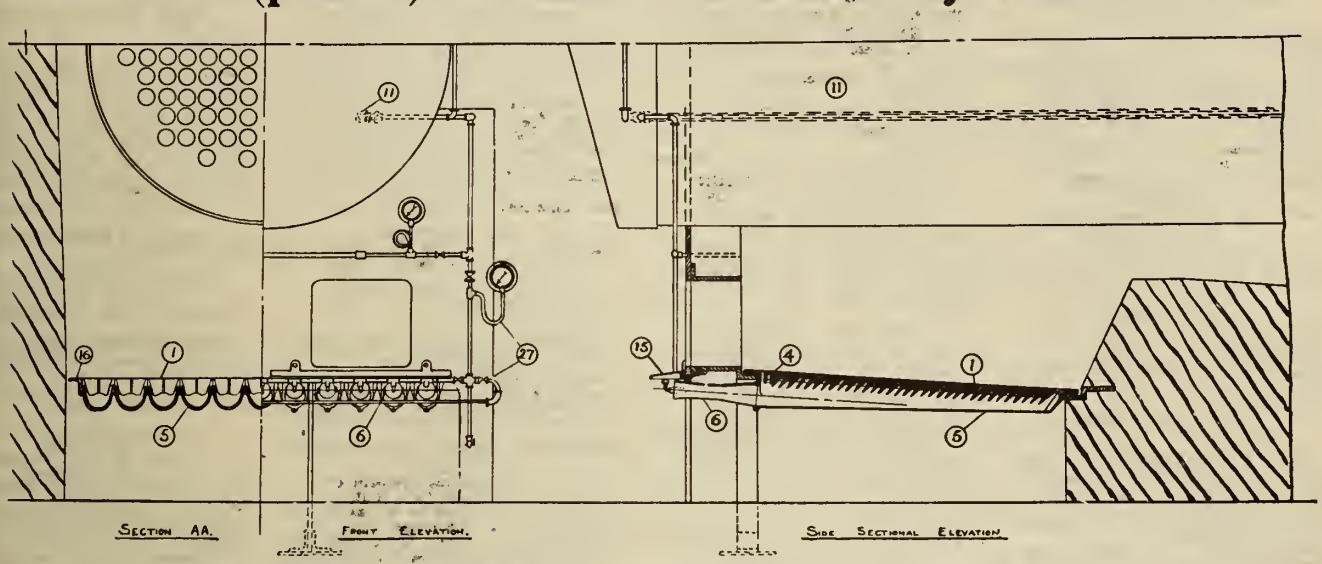

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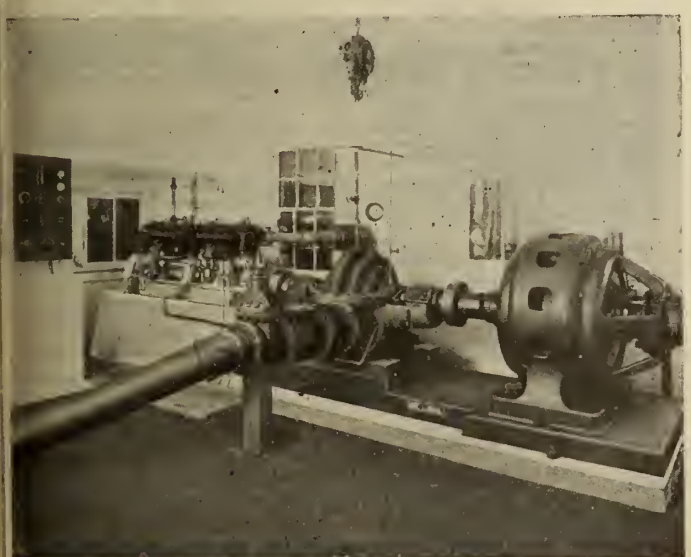

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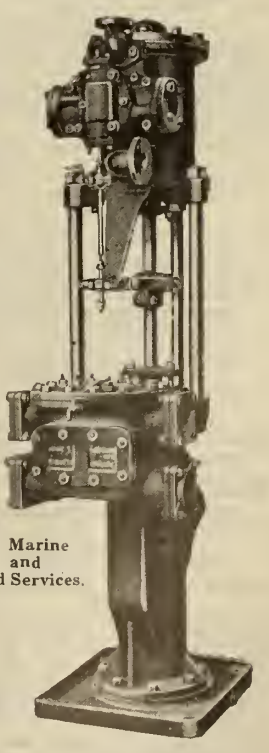

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Leonard & Sons, Ltd., E., London, Ont.
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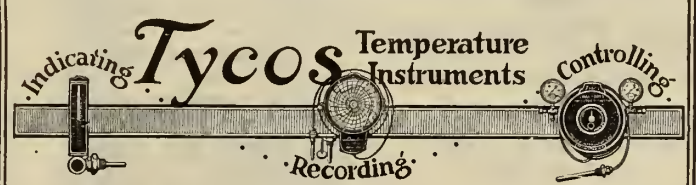

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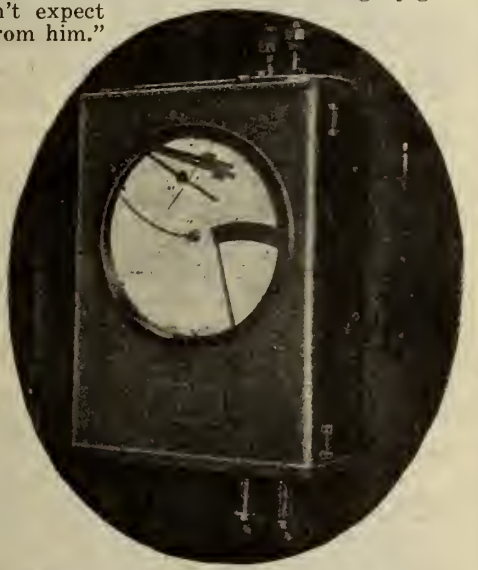

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Furnace operation is also carefully recorded. The charts show the Steam Flow in red, the Air Flow in blue and the Flue Gas Temperature in green. Absolutely reliable, the Bailey way is the Economy way.

Let us tell you the story. It's complete in the Bailey Bulletins.

Bailey Meter Company

2001 E. 46th St., Cleveland, Ohio.

Ever Have Material Spoiled By a Slip-Up on Temperature

It's a common and often costly occurrence when temperature is gauged and regulated by hit-or-miss guesswork—and it occasionally occurs with the complicated automatic controls that easily get out of order.

But it simply can't happen with a Sarco Temperature Regulator on the job.

Set the Sarco at any desired temperature from 32 deg. F. to 300 deg. F., and exactly that temperature will be maintained from beginning to end of the process—the slightest variation above or below will instantly and invariably be corrected. No watching, no attention of any kind.

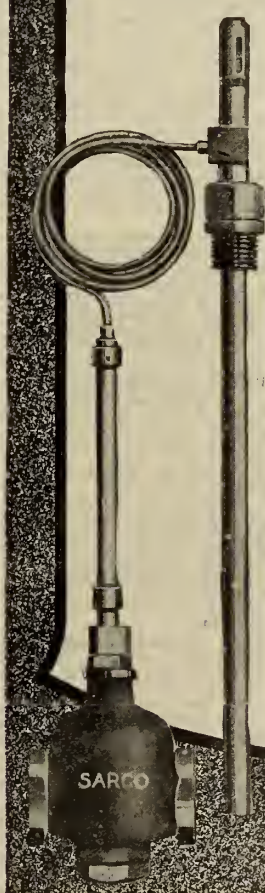
SARCO

Temperature Control

is a revolutionary improvement in automatic heat control—revolutionary in its simplicity, revolutionary in its absolute certainty and dependability.

Entirely self-contained and self-operating—operates through a system of **liquid** expansion and contraction that is as sure as the law of gravitation. No electricity, no compressed air or water, no outside attachments or outside aid of any kind.

Sarco costs less than any other heat control on the market—because so simple. Also much easier to install.



And this same simplicity is what makes Sarco so dependable in operation—nothing that can deteriorate or lose efficiency.

Sarco Temperature Regulators operate on either gas, steam or hot water heat. They can be supplied to meet the requirements of practically any manufacturing process — including the most delicate. Also for control of room temperature in hotels, apartment houses, etc.

Sold on 30 days' free trial—if not satisfactory, simply return it and it costs you nothing whatever.

For further information write for Booklet No. J-52, which includes full particulars about our free trial offer.

SARCO COMPANY, Inc.

239 Broadway, New York City.
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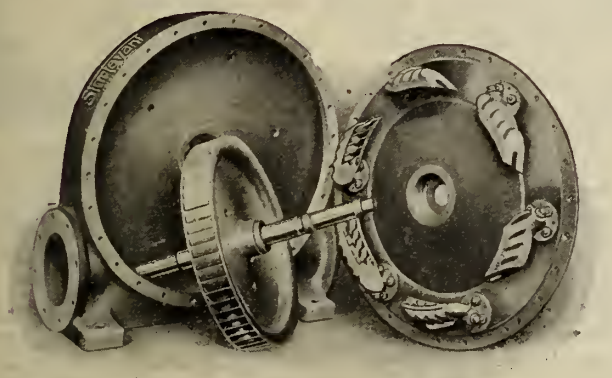
For Low Cost in Operation



Sturtevant Turbine dissembled, showing solid milled turbine wheel, reversing chambers and casing

Sturtevant

"Trade Mark"

Steam Turbines

are well adapted for driving

auxiliary equipment

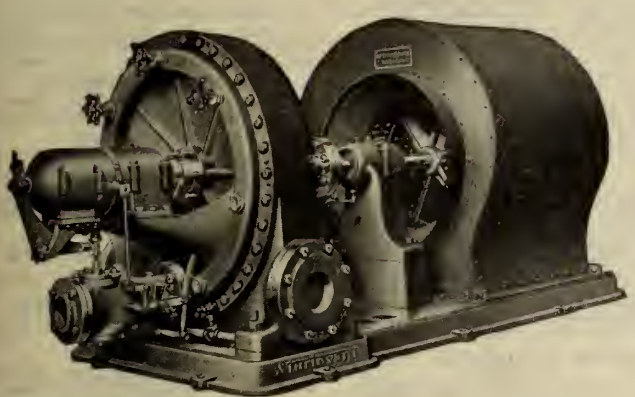
Their excellent record in reliable operation under difficult conditions with a high steam economy maintained under variable load.

The care taken in providing an unsurpassed dynamic balance insures smooth operation and minimum wear in service.

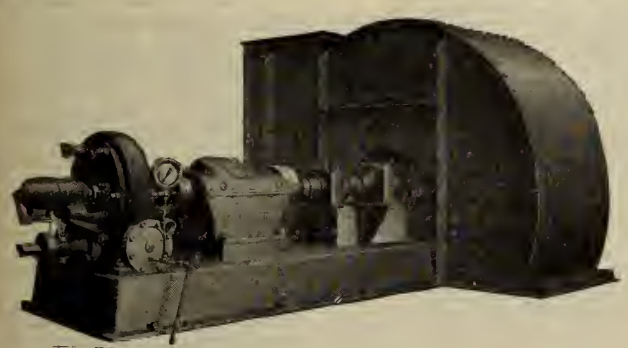
In safety and close speed regulation, the improved governing mechanism has proved itself distinctly superior for this class of small turbines.

Accessibility to all interior parts facilitates routine inspection.

Plant managers and operating engineers should write for Turbine Catalog "V."



Sturtevant Direct-Connected Turbine Fan



Sturtevant Induced Draft Fan driven by Sturtevant Turbine and Reduction Gear

Sturtevant

PUTS AIR TO WORK

Mechanical Draft Equipment

The successful operation of the modern boiler plant depends primarily upon the certainty by which the fires receive the proper air supply at the lowest possible cost.

Sturtevant Forced Draft Fans cover a complete line from the small undergrate blower to the most powerful types for large underfeed and chain grate stokers.

All represent the development of high grade engineering design and unsurpassed construction that insure the maximum in dependability. They can be furnished in units, either steam turbine, steam engine or electric motor driven, built and assembled in the Sturtevant plant and backed by the Sturtevant guarantee.

Sturtevant Induced Draft Fans are designed with a view for maintained economy and low upkeep cost in handling large volumes of hot gases. For chain grate and overfeed stokers and hand firing their installation will result in increased capacity and high flexibility in boiler operation.

Consult the Sturtevant engineers in regard to every draft and ventilating equipment problem in your plant.

Write for catalogs covering this line.

B. F. Sturtevant Company of Canada, Ltd.

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The Superheater Co., Ltd., Montreal.

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Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.
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Babcock & Wilcox, Ltd., Montreal.
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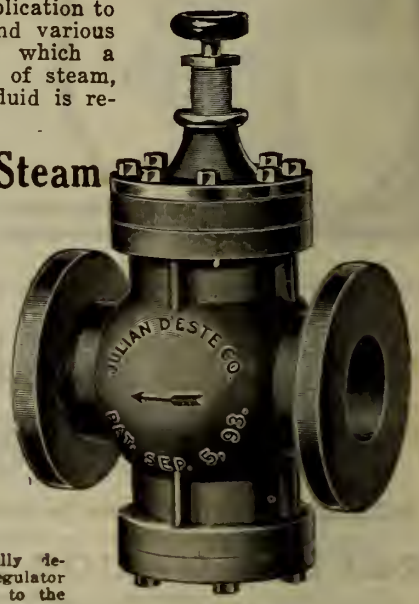

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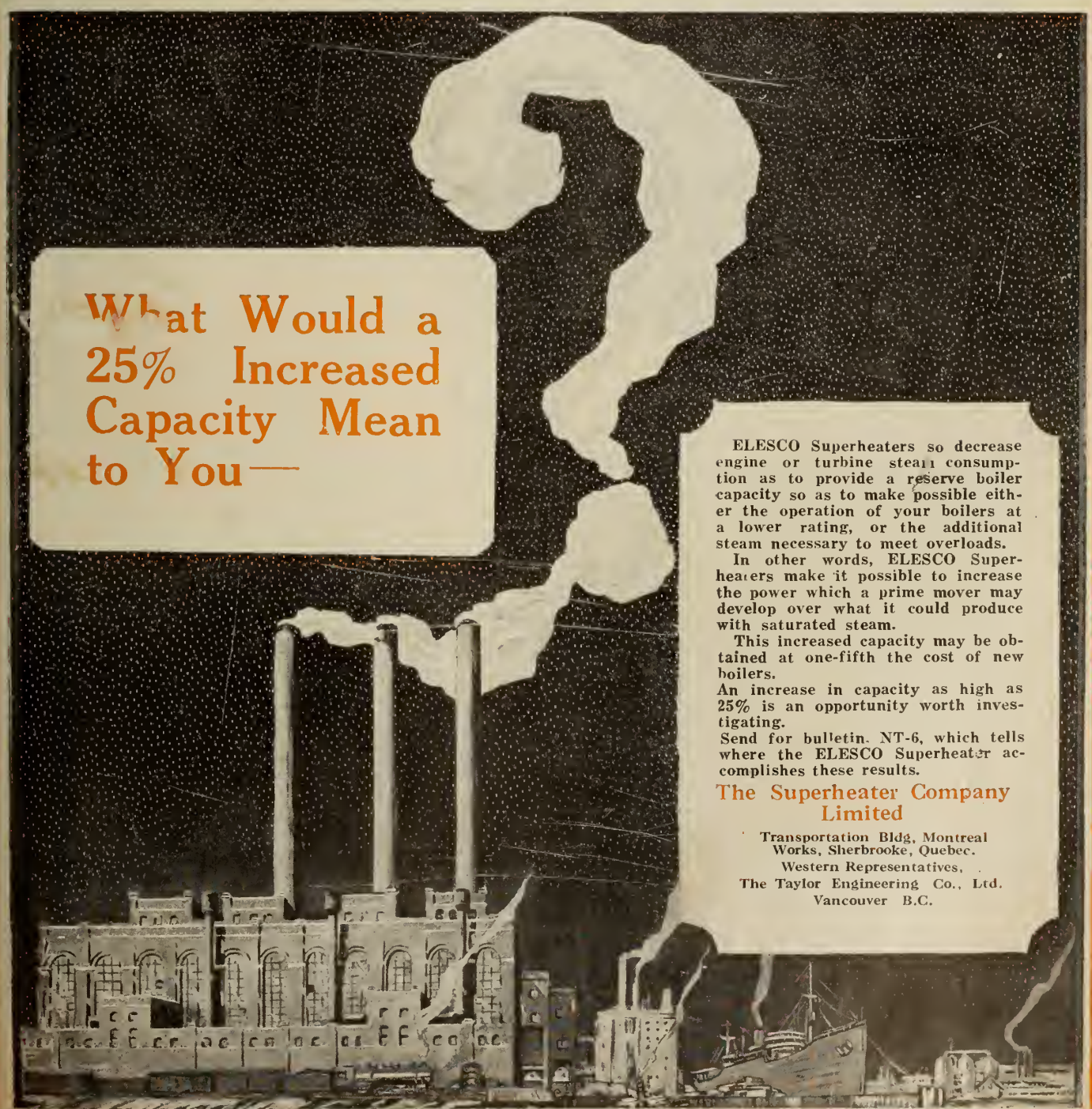

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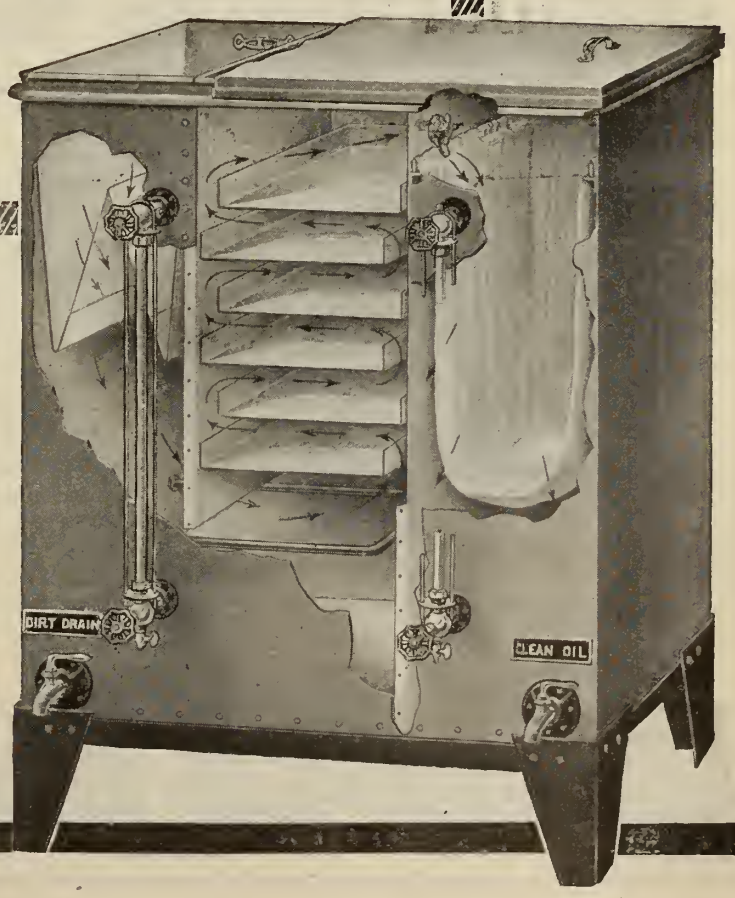

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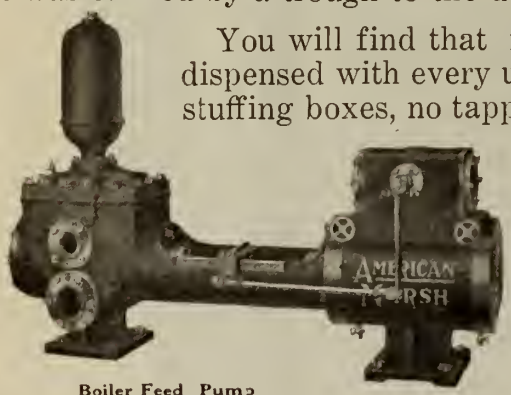

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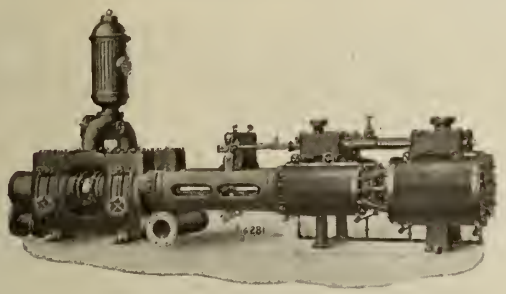
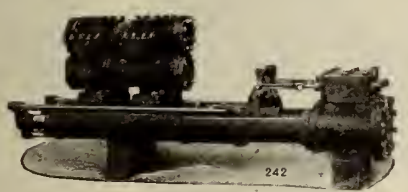


Cut 7581

WATER WORKS PUMPING ENGINE

Direct Acting Steam Pumps
For all Conditions of Service and for All Industrial and Public Utility Purposes.



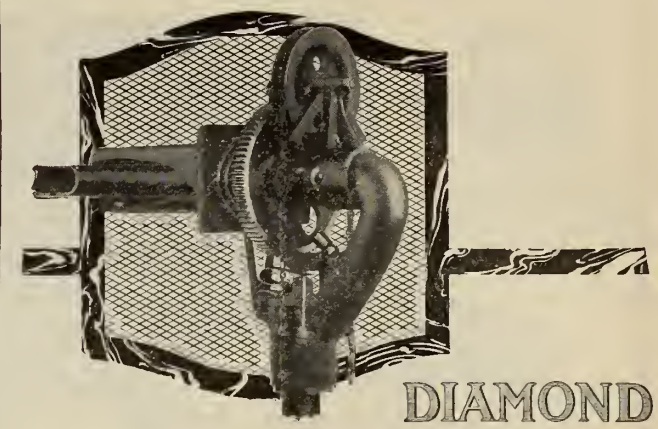
Cut 7242

BOILER FEED AND GENERAL SERVICE PUMPS

Full Line of Water end Patterns Up to and Including Capacity of 5,000,000 U.S. Gallons Per 24 Hours

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

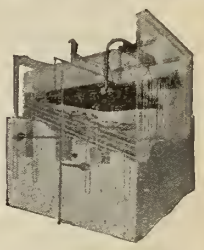


DIAMOND
VALV-IN-HEAD
SOOT BLOWERS

At every point the Diamond Valv-in-Head soot blower effects important savings. For example: Its use assures 100% cleaning efficiency, thus putting many additional dollars a year, as the result of decreased fuel consumption and better boiler efficiency, in the owner's pocket.

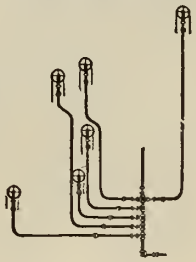
With this system the cost of operation and maintenance is from 1-3 to ½ that of independent valve systems, making it very profitable to replace the ordinary revolving soot blower heads with the new Valv-in-Head.

Consider the matter of pipe, valves and fittings on new installations. A saving is effected of practically 2-3 in the actual length of pipe required. The elimination of expensive individual control valves in favor of the Valv-in-Head is an important cost consideration. This decreases the initial cost of these items by ½ to 2-3 and reduces radiation losses from the soot blower lines proportionately.



Valv-in-Head System—25 feet of pipe, no independent valves.

On a typical six unit installation, with the independent valve system 83 feet of pipe and six 2″ individual control valves are required. With the Valv-in-Head only 25 feet of 2″ pipe and no individual valves are required. With this six unit installation the saving in cost of pipe, valves and fittings effected by the Valv-in-Head system is approximately 64 per cent. The comparisons are: ....



Independent Valve System—83 feet of pipe, six 2″ valves.

Using "Bronze body valves, nickel seats and discs."

Independent valve system	$249.44
Valv-in-Head System	90.83
Saving by latter	$158.61

Every boiler needs a mechanical soot blower and you will save money by buying the best. Diamond Valv-in-Head blowers are adapted to all types of water tube boilers. On request our Service Engineer will go over your existing soot blower installation and advise whether it can profitably be replaced with the Diamond Valv-in-Head system.

Ask for your copy of Bulletin 287 describing the new blower.

DIAMOND SPECIALTY COMPANY,
WINDSOR, ONTARIO

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

New Truths and Old Fallacies

Lubricating Quality--*Continued*

Some years after the United States Government tested Magnolia Metal, the French Government also became interested and made an elaborate test of it, resulting in its endorsement for use by the French Navy.

In this test with "black lubricating oil," 710 lbs. load per square inch, 6.56 feet per second, the frictional co-efficient was 0.0012.

In 1912 Professor Robert H. Smith, before referred to, tested Magnolia Metal with water lubrication and in his report says: "This test proves that bearing A (Magnolia) can be easily run continuously at over 130 lbs. per square inch load at from 400 to 450 R. P. M. with water lubrication."

While it was never expected or claimed that Magnolia-lined bearings could be run independent of lubrication, the tests by the Government and Professor Smith and occurrences in actual service lead to the conclusion that it can be done successfully in many cases.

Mr. Martin L. Baldwin, founder and machinist, St. Clair, Michigan, recently reports having been called, during the night, to re-metal the bearings of engine of the City Electric Light plant. He used Magnolia, and in his hurry to start up the engine he forgot to provide oil hole and grooves. To use his own words, he said: "In the morning my mistake occurred to me, so I hustled to the plant and to my astonishment found engine running as smooth as glass and not heating. We ran engine a number of days before taking apart again."

Another case reported to us occurred in the establishment of Mr. George A. Diemer, Newburgh, N. Y., where Magnolia bearings on a head shaft for motor drive have not received a drop of lubrication in over twelve years, and very likely are still running. That Magnolia will save in lubrication is a matter of course and is mentioned too often to excite notice and naturally the deposition of small particles of worn metal in the oil recovered will be comparatively slight.

(Continued next month.)

Sold by leading dealers everywhere or by

MAGNOLIA METAL CO.

OF CANADA, LIMITED

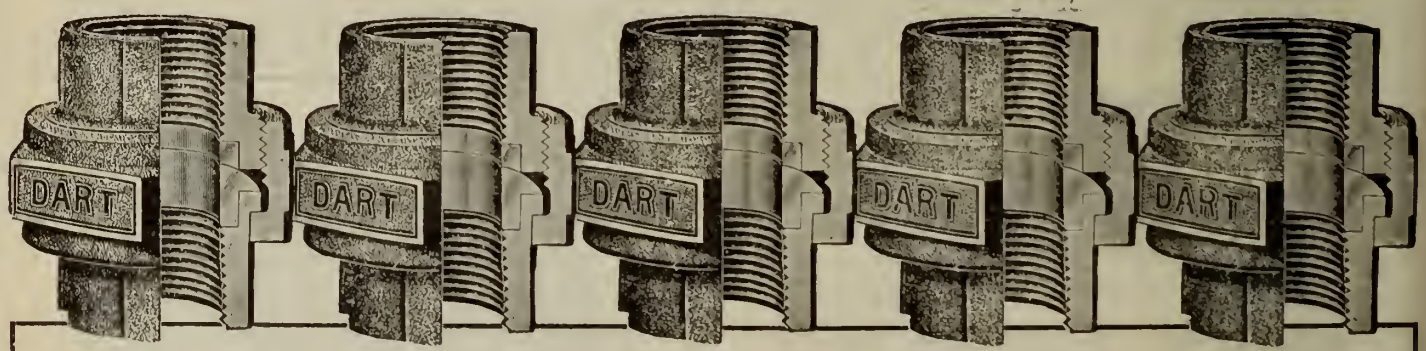
Office and Factory:

MONTREAL: 37-39 SHANNON ST.

For copy of complete article:

"New Truths and Old Fallacies"

Address our Montreal Office.



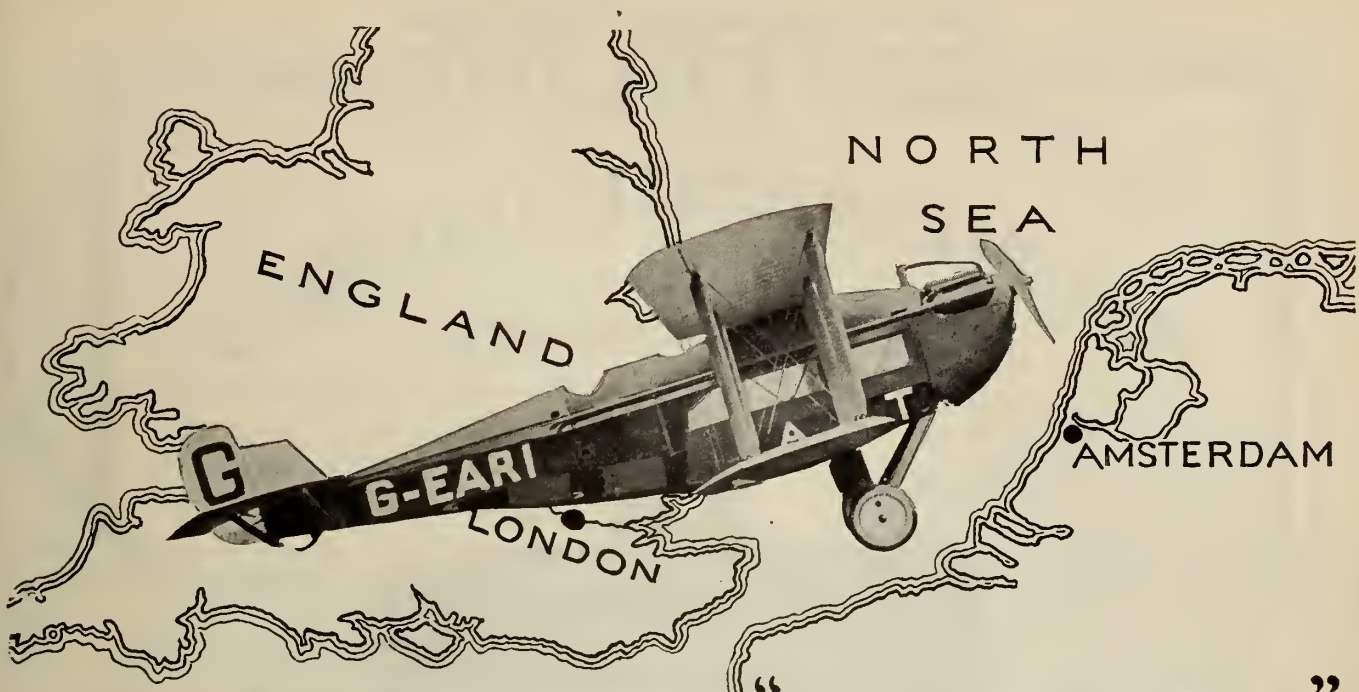
Dart Unions Are A Permanent Investment In A Pipe Line

The Bronze to Bronze feature eliminates all possibility of deterioration at the vital part. Bronze will not rust or corrode.

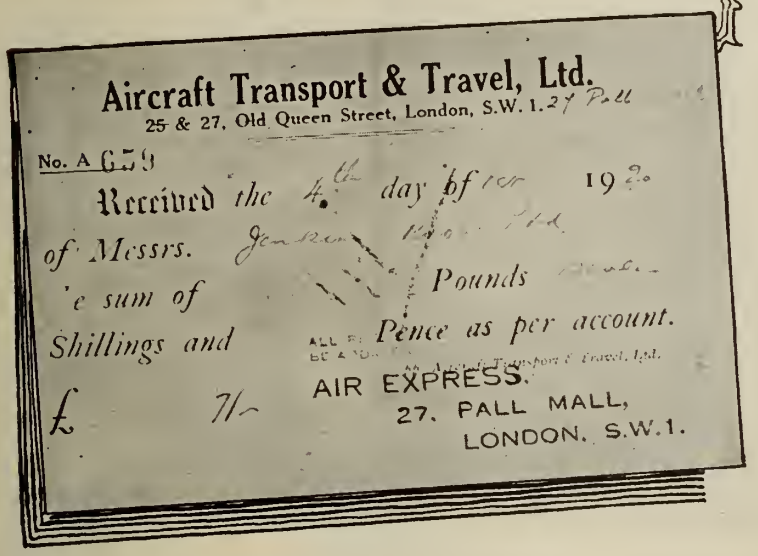
Iron Parts are Extra Strong. They will not stretch or pull apart under strain or heavy pressure.

Never scrap Dart Unions—use again—they're always efficient.

Manufactured by Dart Union Co., Limited, Toronto, Ontario



"SHIP BY AIR" —*We did*


Aircraft Transport & Travel, Ltd.
25 & 27, Old Queen Street, London, S.W. 1.
No. A 659
Received the 4th day of Oct 1920
of Messrs. Jenkins Bros Ltd
the sum of Pounds
Shillings and Pence as per account.
£ 11-
AIR EXPRESS.
27, PALL MALL,
LONDON, S.W.1.

Messrs. Peck & Co., of Amsterdam, Holland, wanted Jenkins Valves—and needed them in a hurry. Their order said "Ship by Air." Our London office dispatched the valves by aeroplane over the North Sea to Amsterdam, where they were received by Messrs. Peck & Co. the same day.

Among experienced engineers and those who know valves and valve requirements there is no substitute for Jenkins Valves—they are valves of established dependability that may be placed in service and forgotten as far as trouble is concerned.

Jenkins Valves benefit by over half a century of valve manufacturing experience. That their design and construction is correct has been proved by performance for many years. More metal, and the best metal, is put into Jenkins Valves—it is properly distributed—there is no weakness at any point. Each valve in every type is safe and dependable in the unusual as well as usual service.

Jenkins Valves are obtainable through supply houses everywhere—the genuine have the name and Jenkins "Diamond" cast on the body—without this identification a valve is not a Jenkins. Avoid imitations.

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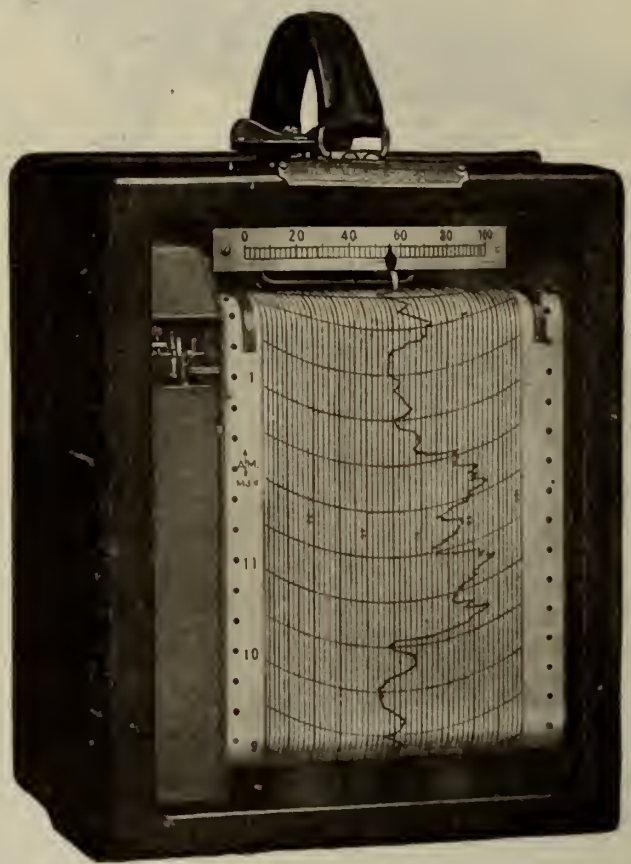
Jenkins Valves

ESTERLINE

TRUE RECORDING INSTRUMENTS

Portable and Switchboard Types



Graphic Wattmeters **Graphic Voltmeters** **Graphic Power-Factor Meters**

¶Ideal for generating stations, sub-stations, industrial and isolated plants where the value of a true load curve cannot be overestimated.

¶The Illustration shows one of the Portable Graphic Meters, which is placed in an aluminum case with a glass face. The clock has an eight-day lever movement controlling the chart which is six inches in width and twenty-six feet long. A special inking device has been arranged for the marking of these charts. The holder will contain a supply for eight days and the ink is drawn through a tube to the pen by capillary action.

Write our nearest House for full information

Northern Electric Company
LIMITED

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PROTECTION

All of our ring packings are enclosed in press-board tubes, that hold the rings in shape and keep them from dirt and dust which are so injurious to rods. These tubes are placed in boxes, each bearing our label, trade mark, style number and the name of rod for which the packing is intended.

The illustration shows Garlock style No. 200, High Pressure Ring Packing, unsurpassed for use on rods working under highest of modern pressures and superheat.

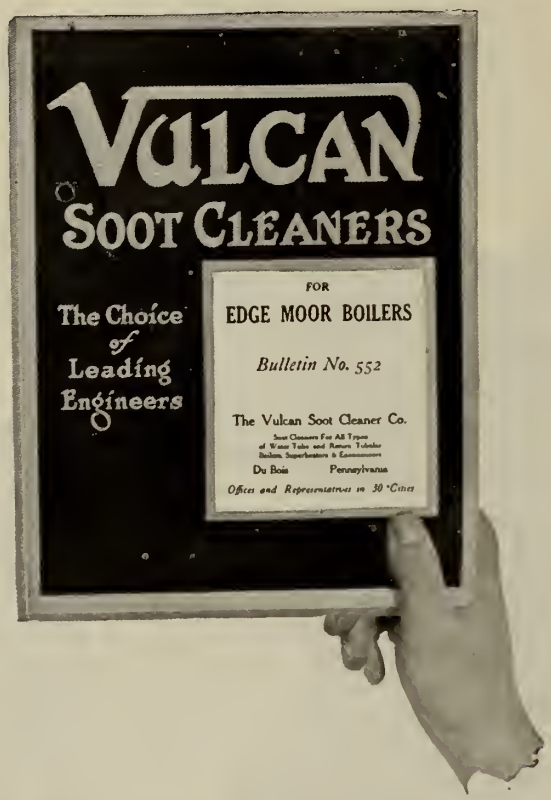
GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONT.

--Branches--

Montreal, Que. Toronto, Ont. Vancouver, B.C. St. John, N.B. Calgary, Alta. Winnipeg, Man.

Keeping Your Winter Coal Costs Down



Clean heating surfaces are a guarantee that each unit of heat will accomplish its expected purpose of turning a given quantity of water into steam.

Dirty heating surfaces are equally a guarantee that many units of heat will fail to register.

Dirty heating surfaces, therefore, reduce the producing value of every dollar's worth of coal burned. In many cases this reaches as much as 10% to 25% of the total coal consumption.

Vulcan Soot Cleaners keep the heating surfaces clean and free from soot, thereby giving ALL the heat its proper chance to turn the water into steam. They are at least 50% more effective and more thorough than ordinary every-day hand lance cleaning, are easier to handle, perform their task quicker and with less labor, and entirely eliminate the dirty, disagreeable work of hand cleaning.

Vulcan Soot Cleaners are, in this day of conservation and the strictest economy, a really substantial dividend-paying investment.

The Bulletin illustrated is No. 552, describing the Vulcan Cleaner for Edge Moor Boilers. Other Bulletins are: No. 534, for Return Tubular Boilers; No. 547, for Wickes Boilers; No. 548, for Stirling Boilers; No. 550, for Connelly, Badenhausen and Erie City Vertical Boilers; No. 556, for Keeler, Geary and Union Boilers; No. 541, for B. & W Boilers. (No. 541 also applies to Goldie & McCulloch Boilers.)

We shall be glad to send you the Bulletin applicable to your boilers.

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES

WINNIPEG
William W. Hicks & Co.
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Beveridge Supply Co., Ltd.

TORONTO
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ENGINEER
You Want This Book

"MODERN FURNACE BUILDING" contains much valuable engineering data, with instructions as to the best methods of installing and repairing baffles, side walls, bridge walls, front-door arches — all boiler settings. Illustrations and detailed drawings add interest and value to the book.

It is yours for the asking. Write us or our agents.

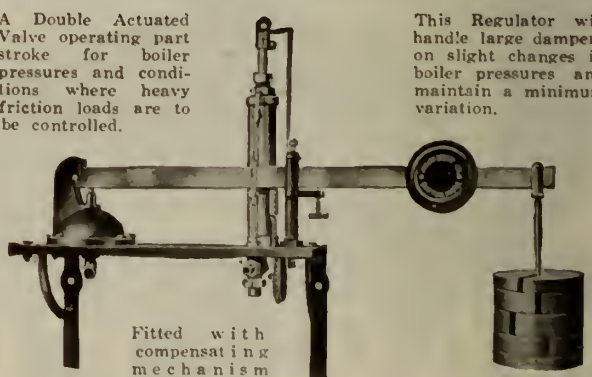
DISTRIBUTORS:—Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply & Fuel Co. Winnipeg, Man.; Gorman, Clancey & Grindley Calgary, Alta.

JOINTLESS FIRE BRICK CO.
1142 CLAY ST., CHICAGO, ILL.

D'ESTE
Hydraulic Damper Regulator

A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.

Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.

Julian d'Este Company

Main Office: 26 Canal St., Boston 14, Mass.

Agencies:
318 W. Washington St., Chicago.
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Saving a Cent a Pound -- or Twenty

by buying babbitt, which lasts only half as long as Ajax Bull Bearing Alloy, is not economy. It's sheer waste.

The babbitt itself is a minor item in the expense of rebabbitting. It's the time and production you lose while the machine is shut down. Labor costs don't stop, overhead keeps on piling up. Nothing goes down but the net profits.

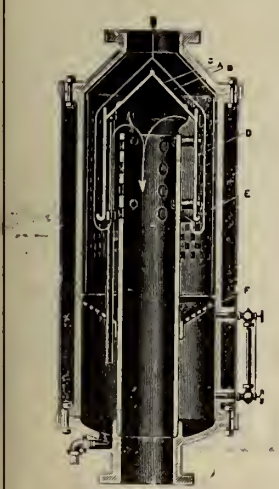
AJAX BULL BEARING ALLOY

wears longer than any babbitt metal because it's made of virgin metals by the Ajax Alloying Process.

Has been used extensively by makers of Heavy Mill Machinery, and several Canadian Mills have adopted it exclusively.

BEVERIDGE SUPPLY CO., LIMITED
628-630 St. Paul St. West, Montreal

10,000 Sweet's Separators are serving discriminating steam users around the world.



Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's Separators

DIRECT SEPARATOR COMPANY

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General Sales Agents

Canadian Fairbanks-Morse Company, Limited

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Firing that is Different

WITH the RILEY STOKER the coal is fed—the fire cleaned—the ash discharged, ***continuously and automatically.***

All done without waste or effort, efficiently and economically.

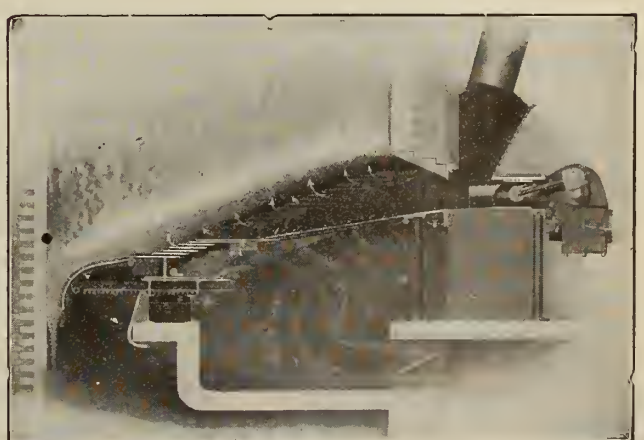
It is not only the things the RILEY STOKER does but the way it does them. For instance, when steam is wanted quickly, and time is precious, you can get this steam instantly and economically by increasing the motion of the grates.

With the first turn of the cranks the grates start moving—the whole fuel bed is thrown into action. There is no watching nor waiting—poking nor slicing—the stoker responds instantly and in two or three minutes the boiler will be operating at 200 or 250% of rating.

It is this kind of flexibility that saves not only for the central station but for the industrial plant.

Catalog H R - 10 sent on request

Sanford Riley Stoker Co.
Worcester, Mass.



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ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

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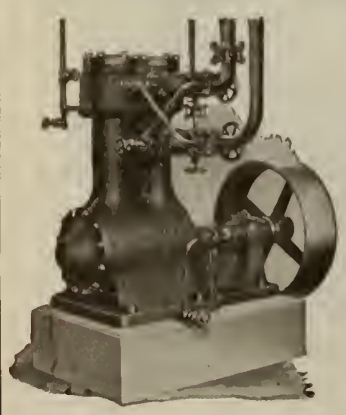

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Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

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The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers -- also your copy of Ice and Frost.

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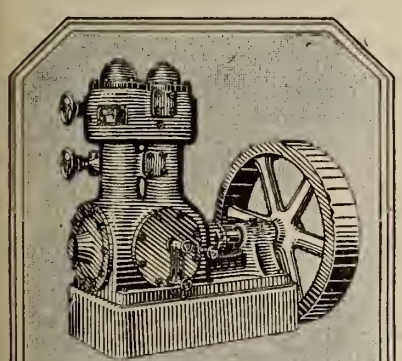
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

YORK



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The governing factor in the selection of Refrigerating Equipment, in most cases, is the reliability of the machine. Can it be absolutely depended upon to perform the work? A shut-down during the warm season is always annoying and often is an item of expense, due to loss of production or deterioration of products in storage.

York Refrigerating Machines have demonstrated their absolute reliability by more than thirty-five years of satisfactory service, which has given them a high reputation throughout the refrigerating field.

Ice and Ice Cream Manufacturers, Meat and Produce Dealers, Creameries, Dairies, Confectioners, Grocers and many other industries are using York Mechanical Refrigeration profitably in the production and marketing of high grade products. If you require Refrigeration in your business, we should be pleased to have you investigate the York System.

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(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA., U. S. A.

There is a YORK Plant to fit Your Business

P⊗H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the out side diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

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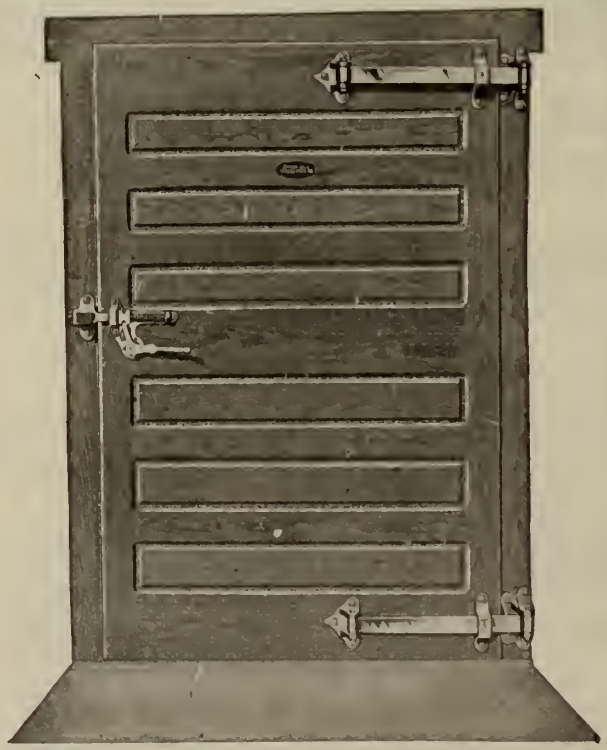
PAGE-HERSEY TUBES, LIMITED

Head Office: **100 Church Street, TORONTO, Ont.**



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 10—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

What is Your Idea of a Good Investment?

TEN per cent. is a good return; it pays out in ten years. But, by saving 80% of the refrigeration lost from uninsulated brine and ammonia lines, Nonpareil Cork Covering pays back its cost in *one* year or less. The return is 100%. For long lines or short ones, large pipes or small, it figures out that way. Local conditions may vary it slightly, but on the average that is the result.

In your own plant, for instance, you can either *lose* the value of the wasted refrigeration, or you can *invest* it in Nonpareil Cork Covering. In the one case, there is no return; in the other, the saving effected pays back the entire investment, not only the first year but every year thereafter for the life of the covering.

And remember—"Lasts Longer than the Pipe" is not a catch phrase, but an actual fact, truthfully descriptive of the remarkable durability of Nonpareil Cork Covering.

8-inch ammonia suction line insulated with Standard Brine Thickness Nonpareil Cork Covering and weatherproofed for outdoor service. Shreveport Ice & Brewing Company, Shreveport, La.

Nowhere else is there available so much accurate information on the insulation of cold lines as you will find in the 64-page book "Nonpareil Cork Covering." If you have bare or inadequately insulated lines, by all means send for this book. There is no charge.

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Nonpareil Cork Covering

For Cold Lines, Coolers and Tanks

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders
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Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System

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Special Castings *Forgings*
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For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

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GUARANTEED TO LAST THREE YEARS

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Drop us a line and let us tell you all about this remarkable packing and our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING CO., WINDSOR, ONT.

In Cotton Tubes

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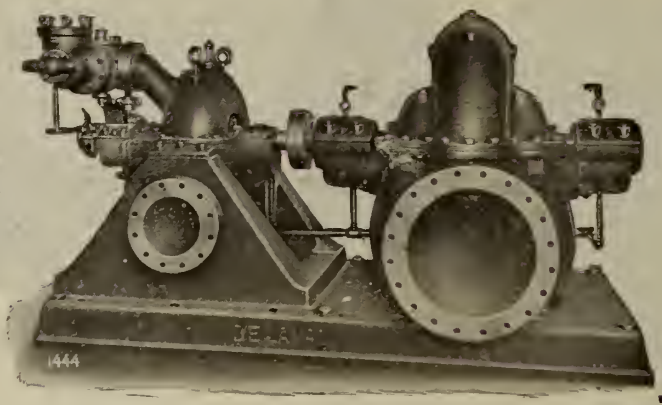

De Laval velocity stage turbine driving blower; 18,000 cu. ft. per min. against 40 in. water column, 3,600 r.p.m.

THIS DE LAVAL CENTRIFUGAL BLOWER driven by a directly connected steam turbine can be depended upon. It is simple and substantial. The blower casing castings are extremely heavy and the impeller and shaft are made of alloy steel. Large bearings and a pressure-oiling system insure reliable lubrication. The turbine is similarly simple and rugged. All working parts of either machine are accessible upon lifting the casing covers. The turbine is controlled by a simple and effective governor and valve gear. Hand-operated nozzles are provided to secure maximum efficiency at different loads.

De Laval blowers are built for all capacities and for all pressures up to 125 lb. per sq. in. De Laval turbines are used for driving all kinds of machinery at all speeds. State nature of your service and suitable literature will be sent.

De Laval Steam Turbine Company

Turbine Equipment Co., 73 King St. W, Toronto. The Laur e Company, Bleury St., Montreal
Taylor Engineering Co., Ltd., Vancouver. 154

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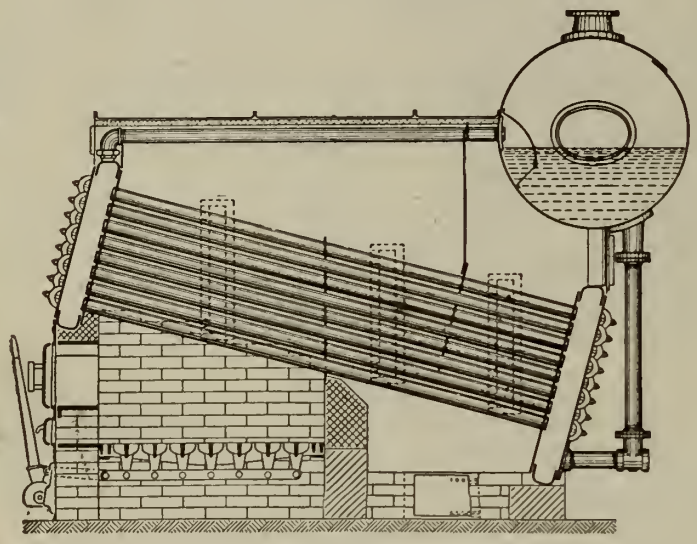

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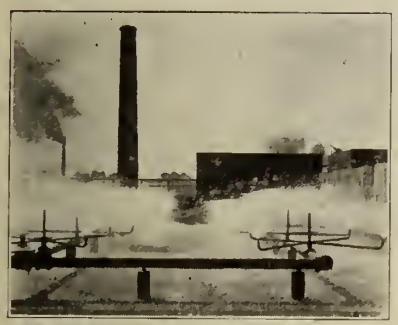

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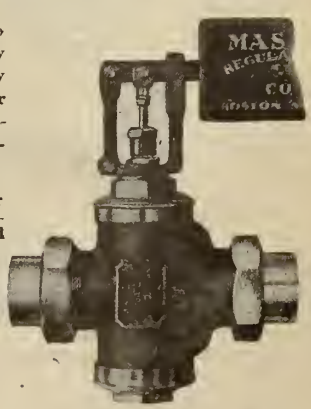

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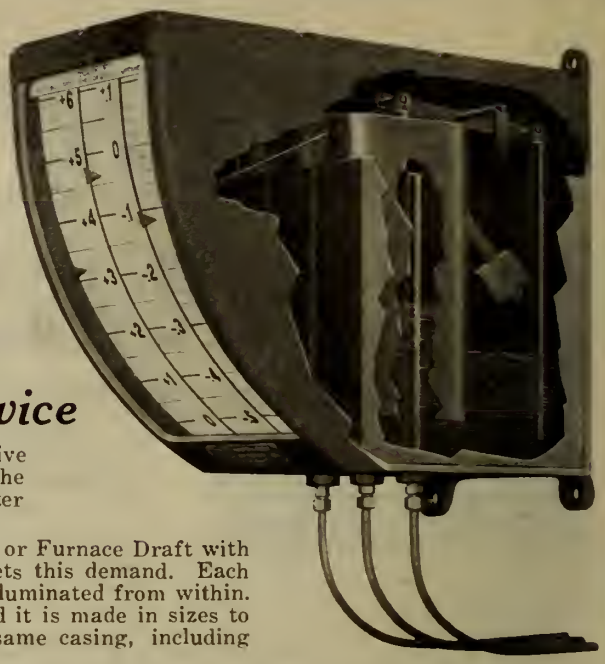

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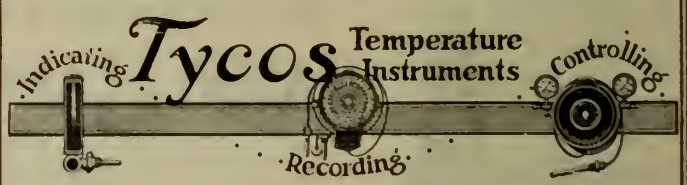

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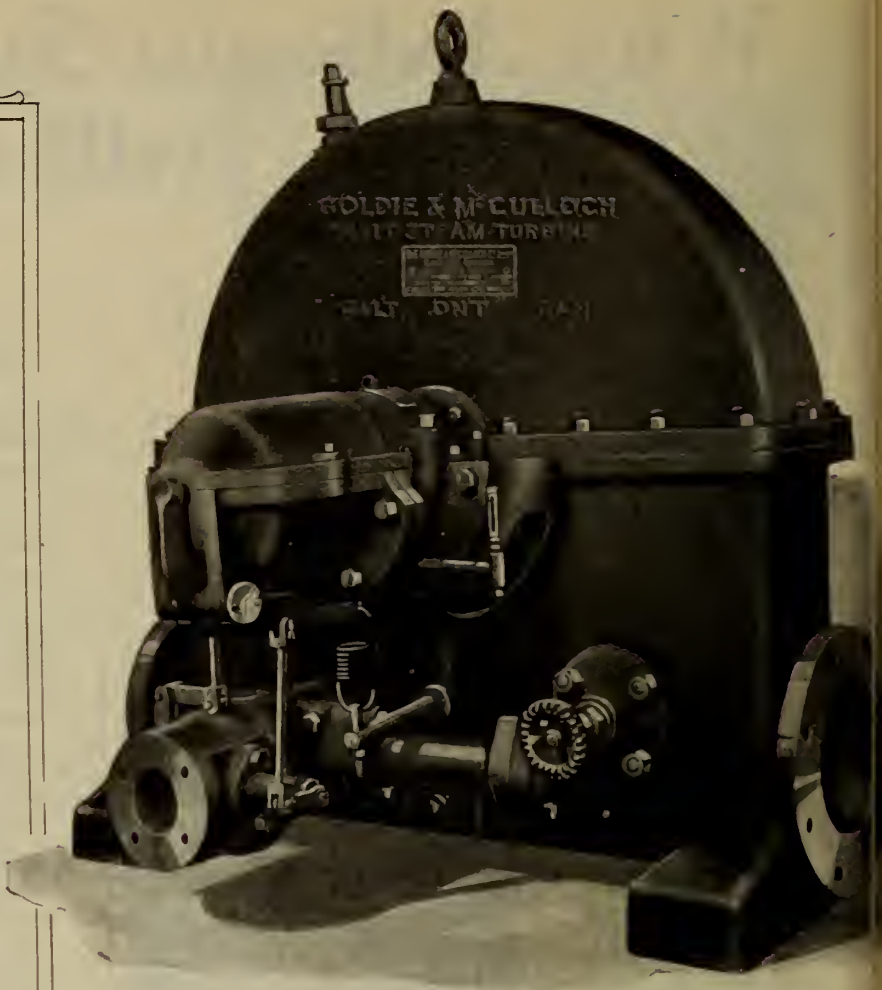

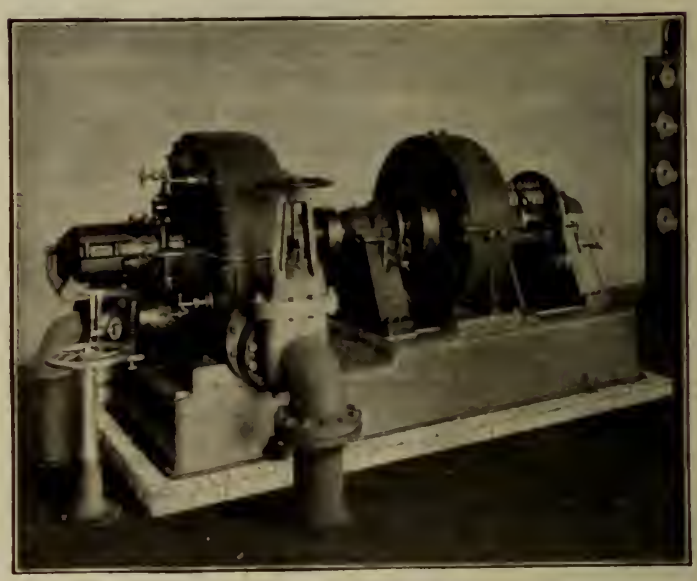

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The Power Plant Journal of Canada

Published in Toronto

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A Review of Power Plant Evolution

Limit of Development Along Old Lines Practically Reached—Ferranti's Proposed Turbine Cycle—The Emmet Mercury Boiler—Results Effected by Employment of Mechanical Stokers—Economiser Problems—Feedwater Heating

By *C. F. HIRSHFIELD, DETROIT

FEW people who are not directly interested realize the tremendous extent to which both modern industrial life and modern family life are dependent on electric energy, or electric power as it is more commonly called. The revolutionary changes in industrial methods which followed the introduction of the water wheel and steam engine have been treated extensively in literature, and almost everyone who reads and thinks knows that the entire social structure of today rests, ultimately, on these prime movers. The part played by electric power, however, has not been so widely advertised and is not so well appreciated.

It is practically impossible to obtain accurate and complete data of the electric power output of the country but it may be stated that the per capita consumption of central-station power has increased from 23 kw-hr. in 1900 to 435 kw-hr. in 1920. These figures represent the growth over a fairly short period and are indicative of the rate at which electrical power has come into use in the country as a whole. As a matter of fact, however, they do not tell the whole story, because much of the electric power used by street railways is not included and because the total population of the country has been used as the divisor. Since the greatest use of power is in the large and small industrial centres, division by the total population of the country gives too small a figure.

To indicate the significance of this feature Fig. 1 is presented. This figure refers to the city of Detroit, which has had a most remarkable growth, and it is therefore not properly representative of all industrial centres, indicating a somewhat extreme case.

Obviously the production of power by central stations is one of the important items in modern life, and the increasing extent of its use has reacted upon the industry of power generation in a most remarkable way. In the case of fuel-burning stations, to which these observations are confined, the development of most economical apparatus, the improvement of load factor, and the refinement of operating methods have all been such that there has been almost continuous decrease in the cost of production per unit of output. It should be understood that this decrease results not only from the more economical use of fuel but also from better use of capital and labor. It is of course common knowledge that the selling price of electrical energy has recently risen in practically all parts of the country. This has been due to abnormal prices of all materials, supplies, and labor, as well as to the attitude of labor toward work. These things are probably all temporary, and it is expected that their effects will disappear in due time.

Three things have had a predominating influence in bringing about these results, namely—

a. Improved load factor
b. Increasing size and efficiency of steam turbo-generators, and
c. The introduction of efficient mechanical stokers.

It is difficult to give average values for the purpose of showing load-factor improvement because conditions vary greatly from place to place and time to time. However, it will help somewhat to point out that as a central electric supply changes from a pure lighting to a combined lighting and power supply, the load factor changes from something of the order of 10 per cent or less to a value between 50 and 70 per cent. Obviously capital charges per unit of output in the first case are extremely heavy when compared with capital charges in the second case.

The size and efficiency of steam turbo-generators are, of course, readily expressed in numerical form. Fig. 2 is given to illustrate the marvelous developments which have occurred within two decades.

The introduction of efficient mechanical stokers has had two quite different effects. The boiler-room thermal efficiency has been increased to a remarkable degree and the size of units has grown tremendously. In 1900 most central stations were equipped with boilers containing not over 5,000 sq. ft. of heating surface. This size has been increased gradually until now units containing between 12,000 and 24,000 sq. ft. are in common use. Paralleling the increase in thermal efficiency and in size, there has been an increase in the efficiency of use of boiler-room labor. It is now possible for one fireman to take complete charge of 5,000 rated boiler horsepower.

Limit of Development Along Old Lines Practically Reached

At the present time we seem to have reached very close to the limit of ultimate development along the lines which have been followed during the past two decades. This statement, however, is not meant to imply that there is no further room for improvement in central stations as they now exist. Obviously, no central station not built within the past year or two can contain all the latest developments. Almost all central station companies operate one or more old plants which could be improved by reconstruction. In many cases this reconstruction can be economically justified and is being carried on or is contemplated. Nor does it mean that we are unable to build more efficient plants than those just completed.

The real significance of the statement is this: Since about 1900 we have pursued a fairly consistent sort of development along fairly definite lines. During the entire period further possible improvements were always visible and one could predict with a reasonable degree of certainty that each suceeding year would produce certain definite modifications and advances. Now we seem to have reached a point where marked increase of economy in the use of money, labor or fuel can be made only by radical changes of some sort.

*Chief, Research Department, The Detroit Edison Company. Mem. Am. Soc. M.E.

Presented at a meeting of the Cleveland Section of The American Society of Mechanical Engineers, March 1, 1921. Slightly abridged.

Rather curiously we arrived at this point in the evolution of the art at just the time when there was the greatest need of conservation in the use of capital, fuel and labor. The driving force furnished by the excessively high prices for money, fuel and labor which have characterized the last two or three years would have been sufficient to cause improvements of tremendous magnitude had we known just what direction to take. Unfortunately we found ourselves at a sort of parting of the ways, and the best brains in the industry in this country and in Europe have been, and are, trying to map the road to be followed in the immediate future.

Out of the work already done have come several definite indications, but the author cannot feel that any of them promise enough to justify us in concluding that they mark the way. Rather are they to be considered merely as the finishing touches to the existing type. It is his belief that we are just polishing off the steam-turbo-generator type, and that while we may be forced to continue doing so for quite a few years, we are essentially marking time while waiting for a new, epoch-making design, invention or development.

There is nothing now in sight which promises any change so revolutionary as the introduction of the steam turbine or the stoker, but this must not be interpreted to mean that the author does not believe something of this sort is coming. He feels perfectly certain that development will be even more rapid in the future than it has in the past and that, as a result, the allowance for obsolescence should be made higher in the future rather than lower. With the foregoing paragraphs to serve as an introduction we may now enumerate and possibly evaluate the changes now occurring and those which are apt to occur in the near future.

All engineers who are familiar with the theory of steam engines and other heat engines know that theory indicates increasing thermal efficiency as upper and lower temperatures of the working substance are moved farther apart. In the case of the steam turbine this is equivalent to saying that the thermal efficiency will improve as the temperature of the steam reaching the unit is raised and as the back pressure, and therefore, the temperature of steam leaving the unit, is decreased.

We already have many stations operating with maximum steam temperature of 600 deg. Fahr. or higher and we are rapidly approaching a temperature of 700 deg. A value between 700 and 800 is generally considered to be the highest that should be used with the metals and alloys and the types of construction now available. In the opinion of the author 700 deg. Fahr. is about as high as we can safely go at present.

At the other end of the temperature scale, we are now operating our best plants with an average back pressure throughout the year of about one inch of mercury, and there does not seem to be any possibility of greatly improving this performance.

Economic Possibilities in Use of Higher Steam Pressure

With the temperature limits thus definitely set and already practically attained, engineers have begun to consider seriously the possibilities of using higher steam pressures without exceeding the upper temperature limit. It is commonly known that the temperature of saturated steam increases with pressure, but the form of the curve connecting pressure and temperature is not generally appreciated. Such a curve is given in Fig. 3. It is obvious that temperature increases very rapidly with respect to pressure at low pressures, but that this relation is reversed at high pressures. At present a few central

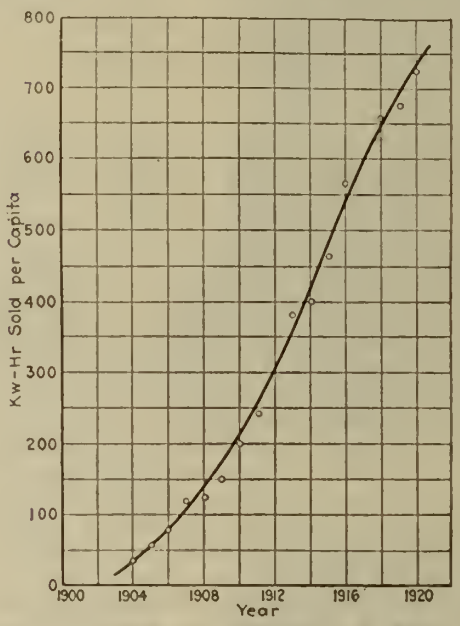


Fig. 1.—Increase in Consumption of Electric Power in Detroit Between 1903 and 1920.

stations are using, or are being constructed to use, a pressure of from 300 to 350 lb. per sq. in. The curve of Fig. 3 shows that saturated steam at such pressures has a temperature well below 450 deg. Fahr. If we assume it will be possible to utilize pressure as high as, say, 500 lb. per sq. in. in the near future, we will reach a saturation temperature only a little higher than 450 deg. Fahr. To attain steam with a saturation temperature of 600 deg. we should have to utilize a pressure of almost 1,600 lb.

It is quite obvious that if we are to operate with the highest permissible temperature we must use superheated steam, even if we increase the maximum pressure to the highest imaginable limit. The curves of Fig. 4 are presented to indicate the theoretical possibilities of higher pressures.

It will be observed that the theoretical efficiency of the cycle increases with increasing pressure for both saturated and superheated steam. It will also be observed that at the temperatures to which we seem to be restricted the gain resulting from increasing the pressure from 200 lb. per sq. in. to 300 lb. is greater than for the next 100-lb. increase, and so on up to the highest pressures shown. Moreover, the maximum efficiency shown is not so much higher than the indicated for pressures and temperatures now in use that radical increase of pressure and temperature holds great promise.

A modern plant with steam pressure between 200 and 225 lb. and with a steam temperature of about 600 to 650 deg. Fahr. can produce power at a cost of about 19,000 B. t. u. in fuel per net kilowatt-hour. If the same ratio between actual results and theoretical efficiency of cycle holds for higher pressures and temperatures, we should be able to produce a kilowatt-hour for about 17,500 B. t. u. with steam at 400 lb. and 700 deg. Fahr. Taking probable extreme limits and assuming 600 lb. and 800 deg. Fahr., the cost of a kilowatt-hour would be about 16,000 B. t. u.

Such figures are certainly worth striving for, but unfortunately they do not tell the whole story, First, the cost of equipment will certainly increase with pressure and, to a certain extent, with temperature. Increased thermal efficiency will therefore certainly be partly offset by increased capital charges. Second, the ratio of actual to theoretical turbine efficiency should decrease with increasing pressure, so that the thermal gain to be derived from high pressures must be discounted to a certain extent. Third, the increased boiler pressure means increased flue-gas temperatures and this must result in offsetting part of the calculated improvement. If this increased loss is prevented by the installation of a device like an economizer of air preheater, we have increased capital and operating charges to consider.

It is the author's opinion that it will be quite a while before we resort to pressures higher than 400 lb. and that fuel will have to cost much more than is probable for the immediate future, while capital must, if anything, cost less to justify exceeding such a value. Against this is to be set the fact that we are now using or preparing to use 250 lb. in this country and that in England they have already exceeded 400 lb.

Ferranti's Proposed Turbine Cycle—The Emmet Mercury Boiler

Many years ago S. Z. Ferranti suggested an interesting modification of the turbine cycle. He proposed to add heat during the early part of the expansion so as to maintain the steam at a constant temperature during that part of the cycle. Practical difficulties led to a modification which has to most people obscured the original suggestion. In the modified form the steam is permitted to expand in the same way as it is now customary, but is completely withdrawn from the turbine at different points, reheated, and returned to continue the expansion. In theory this cycle promises an improvement of about 10 per cent over the cycle now in use. If actually used in an operating plant it is probable that not over 5 to 6 per cent improve-

ment could be shown. Against this would be chargeable increased capital costs and increased operating complications.

It is rumored that this cycle in a simplified form is to be used in a new English plant now under construction: It has actually been used in experimental apparatus, and according to reports the results were satisfactory.

Another interesting suggestion emanates from W. L. R. Emmet. Many binary cycles have been proposed and thermal savings can be calculated for most of them, but the one suggested by Emmet seems to be the most promising. He proposes the use of mercury as one working substance and water as the other. The mercury is vaporized in a fuel fired boiler something like a steam boiler, is expanded in a small turbine and condensed in a device which may be called a condenser-boiler. This device

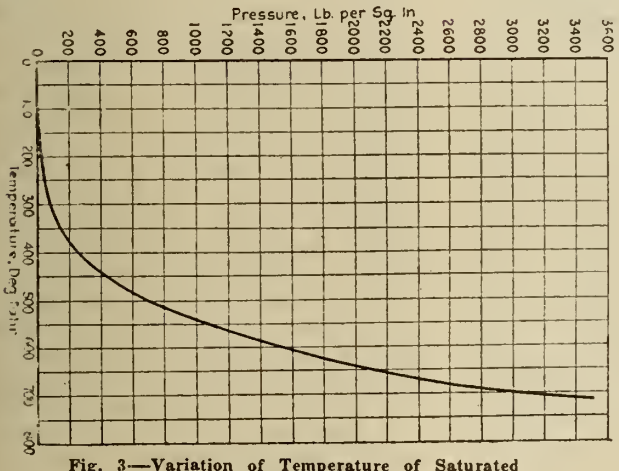


Fig. 3—Variation of Temperature of Saturated Steam With Pressure.

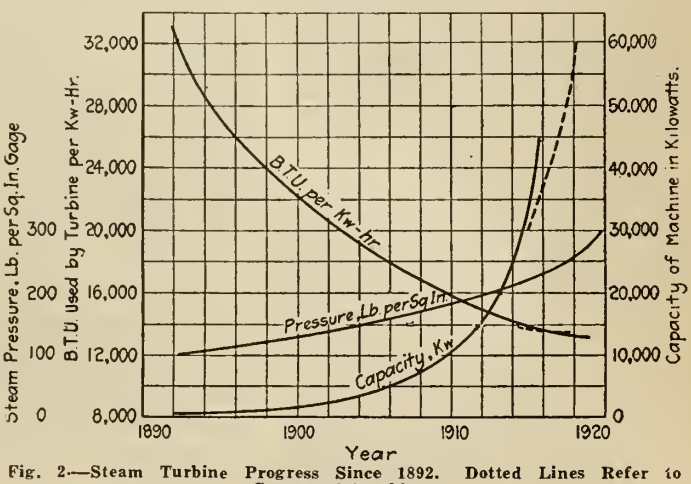


Fig. 2—Steam Turbine Progress Since 1892. Dotted Lines Refer to Compound Machines.

transmits the latent heat of vaporization of the mercury vapor to the water, converting it into steam which is used in a turbine in the ordinary way. Mercury boils at 677 deg. fahr. under atmospheric pressure and at 457 deg. under a pressure of 2 in of mercury. It thus is ideally fitted to extend the upper temperature limit without introducing prohibitive pressures. It also has such other physical characteristics that a comparatively cheap turbine can be used.

This proposal of Mr. Emmet's is by all odds the most promising of the binary types and it seems to be the only one that warrants serious consideration at the present time. It promises a return of about 40 per cent more power from a given quantity of fuel, and this without a prohibitive increase in investment.

Results Effected by Employment of Mechanical Stokers

Turning now from a consideration of the turbine room to the boiler room, the introduction of the efficient and flexible mechanical stoker has reacted in two different ways. It has made it possible to obtain much higher boiler-room efficiency day in and day out, month after month, and is has made it possible to drive boilers at much higher ratings than were even dreamed of a comparatively short time ago. Increasing the quantity of steam which can be produced from a given equipment naturally reduces the overhead charges per unit of steam output.

Now the power producer does not care whether his power becomes cheaper because of more efficient use of fuel or because of more efficient use of capital. Consequently there is evident an increasing tendency to overstoker boilers and to drive them at high average rates. This is quite proper if it is not carried too far. Unfortunately the thermal efficiency of boiler units decreases with increasing output above a certain point, and if the rate of evaporation is carried far enough a point is reached at which decreased thermal efficiency and increased maintenance more than balance the savings in capital. The point at which this occurs differs with the character of equipment, the price of capital, the price of coal, the load factor and other considerations, but under average central-station conditions the most economical point will generally be found below 200 per cent of normal rating if economizers are not used. The addition of economizers naturally raises the proper value. It is probable that the cost of capital and apparatus will ultimately come down to pre-war figures or very nearly to such figures, and it is equally probable that the cost of fuel will not. Under such circumstances the economic balance will probably be found to occur at a lower average rate of evaporation than some designers have expected.

Economizer Problems

One of the principal losses occurring with high boiler ratings results from high flue-gas temperature. This loss can be partly recovered by the use of economizers. However, economizers cost money to install, money to maintain and money to operate, and the waste is not therefore entirely recoverable. Some designers of power plants appear to give inadequate weight to some of the costs incurred in the practical operation of economizers.

It is rather interesting to note in passing that despite the increase in the price of coal during the past six years, the situation with respect to the installation of economizers has not materially changed. The author knows of cases in which quotations on economizers increased during the same period at such a rapid rate that despite the increasing cost of coal the installation of economizers could not be justified. This is probably a transient situation; the cost of economizers may be expected to drop to a point which will place them in a much more advantageous position than that occupied before the war.

But here we are faced with another complication. Economizers until quite recently were made of cast iron exclusively. As the steam pressure in use has risen more and more, engineers have begun to question the propriety of using cast iron for such apparatus. It seems certain that all will agree that if we adopt pressures like those we are now considering, cast iron will be ruled out unless we operate economizers at a pressure much below the boiler pressure. This introduces undesirable complications.

Such considerations have led to the construction and use of wrought-steel economizers. These can be built with factors of safety equal to those used in boiler construction; they are practically as satisfactory as cast iron with respect to corrosion on the gas side, but are much more apt to corrode on the water side. In fact, it is possible to cause failure of steel economizer tubes by corrosion on the water side within a year.

In modern plants such corrosion is generally due to dissolved oxygen and can be prevented if proper precautions are taken to keep the boiler feed sufficiently free of this gas. There are now several well-recognized methods of doing this.

Air Preheaters

Within the past few years another device has been introduced for conserving heat otherwise lost in flue gases. This is the air preheater. Air used for combustion must be heated to furnace temperature from the temperature with which it enters the furnace. Ordinarily this is done in the furnace at the expense of heat liberated by the fuel. That

part of this heat which is required to raise the temperature to a value equal to that with which the flue gases leave the boiler is wasted through the boiler damper.

If a large fraction of this heat could be conserved by transferring it from flue gases to entering air by means of an air preheater, a fuel saving of 10 per cent or more could be made. It does not seem probable that any such complete transfer can be effected in a real case, but some fraction of it is certainly attainable. It appears as though a saving of 3 to 5 per cent might prove possible.

However, this device also introduces problems of its own. It can be built comparatively cheaply, but its use involves additional flues and fans and power for driving the fans, so that the gross thermal gain in any case will be partly offset by increased thermal expenditure and increased capital charges. Further, it seems certain that air preheaters will present new cleaning and maintenance problems which will also yield items of expense which must be balanced against the gross thermal saving.

In addition to all these considerations we have another which may prove of still greater importance. We do not yet know the limiting temperature to which it is permissible to raise the air. The air supplied for burning fuel on the grate or stoker passes through that device and serves to cool it by removing heat which is radiated and conducted to it. It is certain that we can use air temperatures higher than those now common, but whether we will find 150 deg. Fahr. or 300 deg. or 500 deg. to be the upper limit, is still unknown. The author is inclined to think that the upper limit will vary with the type of stoker and it is obvious that is will vary with the rate of combustion.

Feedwater Heating

Great improvements have been made in the character of boiler feedwater used in the large plants of the country in the past decade. In the early days we used for boiler feed or make-up water anything which was readily attainable. If the scale deposited in the boiler was of such character as to cause too much trouble, we treated the water chemically before use. But we still concentrated a chemical solution in our boilers, had to blow down at frequent intervals and were forced to shut down and thoroughly clean them periodically.

We have now greatly improved this practice in the case of plants using surface condensers. In such plants the greater bulk of the water evaporated in the boiler is used over and over, being contained in what one might call a practically closed circuit. There is a certain loss from leakage, blowdown, spillage, etc., but this can be kept down to a value between 1 and 2 per cent of the total boiler feed by careful management. The make-up required to make good this loss is now commonly distilled and enters the system as a vapor, leaving dissolved salts behind in the evaporator.

With a plant operated in this way there is practically no deposit in the boiler. As a result blowdown losses are practically eliminated. Of still greater importance, however, is the fact that the expense of shutting down, opening up the boiler and turbining the tubes is almost completely done away with. In this case the improvement results not so much in a thermal gain as in decreased labor and maintenance charges and better use of invested capital.

Much thought has also been given recently to different methods of obtaining auxiliary power and to different methods of heating the feedwater. These

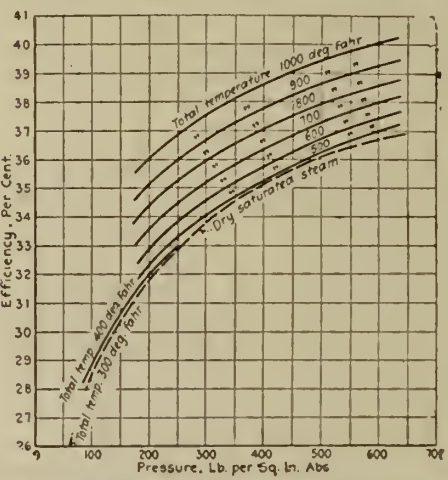


Fig. 4.—Efficiency of Complete Expansion Cycle as Used in Steam Turbines (Back Pressure in L9)

factors are closely tied to the use of economizers and air preheaters, and that method which is best under one set of conditions is not necessarily usable with a different type of plant.

We seem to be settling down to two different types, although the whole subject is as yet admittedly in a state of flux. In the one type steam-driven house generators are used to supply some or all of the auxiliary power. The steam exhausted heats the feedwater in heater-condensers operating at such a vacuum as to give a feedwater temperature sufficiently low for advantageous use in economizers. In the other type the feedwater is heated by steam drawn from the main unit. This heating is preferably done in stages, and if the idea is carried to the limit, it results in the introduction of a cycle which is theoretically more efficient than the simple, so-called Rankine cycle now in use. Unfortunately, if this arrangement is carried to the ultimate limit it yields feedwater with a temperature higher than can be used advantageously in economizers. It also has another disadvantage from the view-point of the central station. Auxiliary power must logically be taken from the main bus and continuity of service is correspondingly jeopardized.

Utilization of Low-Grade Fuels

No consideration of the evolution of power plants would be complete without a reference to the work which is being done in an effort to make available for use the poorer grades of fuel. Stokers are continuously under development and we are already obtaining very promising results with fuels which only a few years ago were practically unusable. Further, many attempts are being made to introduce pulverized fuel into central-station boiler rooms, and one large new plant is being completely equipped for the use of such material. Much is promised by the pulverized-fuel advocates in the way of increased thermal efficiency, decreased labor charges, and ability to use poorer grades of coal. As yet the case is not proved, but the experience of the next five years should bring out the facts. Personally, the author believes that the preparation of the fuel for the burner must be greatly simplified and cheapened before pulverized coal can compete with good stokers under central-stations conditions in most sections of the country, but it must be confessed that many engineers in the industry do not share in this view.

So much for the trend of the times in power-plant design. It will now be of interest to attempt to evaluate all the possible improvements in sight.

Future Possibilities in Plant Efficiencies

If we assume that we will continue to use steam turbines and other equipment of the present types, but that we will increase pressure and temperature to the limit and will introduce all possible heat-saving devices, we can lay down on paper a plant which should deliver a net kilowatt-hour for between 14,000 and 15,000 thermal units. This would correspond to overall thermal efficiencies of the order of 24 or 23 per cent. Our best plants of the present day give values of 18 to 19 per cent.

The author is certain that with the fuel prices which are to be expected in this country in the immediate future, such thermally efficient plants would not represent the best engineering or economic solution of the problem. The investment would in his opinion be higher than could be justified. On the other hand, he does expect to see a figure between 16,000 and 17,000 attained in the very near future.

NEW INSTALLATIONS

The town of Barrie, Ont., has installed a 225 horse power Sterling Engine and a De Lavel pump of 1,500 gallon per minute capacity to replace the present steam equipment.

Mr. J. H. Bennett, Power and Light Commissioner of the town, also informed Power House that they will install a 500 gallon De Lavel electrically driven centrifugal pump to supplement the present electrical equipment. The present equipment (steam) will be disposed of, and a list of this equipment will be found in the advertising columns in the near future.

Overhauling and Adjusting in the Engine Room

In this Article the Author Has Something to Say About that Much Abused Article, the Steam Trap. He Mentions the Principal Types, and Seems to Think that Their Usefulness Depends on the Kind of Care They Get

By "FITTER."

THERE is perhaps no one source of loss that does greater damage to the fuel consumption than leaky and inefficient steam traps on steam and return mains. An open ended pipe is not such a serious source of loss as a pipe with an inefficient trap on the end of it. In the first case the loss is seen, and will be choked down as much as possible, but a trap that is continually blowing steam through, instead of trapping it, is a source of unseen loss that may mount into big figures. The necessity of continual care of these appliances is therefore obvious.

Various Types of Traps

The variety of traps is almost infinite, and there always seems to be a sample of half a dozen different kinds in every steam plant, the larger the plant, the more types of traps being the general rule. This is due to the indiscriminate purchase of traps without considering the special duty they have to perform, and also to the fact that a good many engineers will purchase a new trap rather than try and make the ones they have work properly. Of necessity, traps are often situated in places where they are hard to get at, and the temptation is to leave them severely alone, and in some cases to put on an additional trap further along the line where it can be seen. Systematic examination and adjustment of traps is the only possible way to obtain satisfaction. Almost every trap on the market will perform its duty if given a chance, although this does not mean that some traps are not better designed than others. The trouble with almost every kind of trap is that it demands a great deal of attention, and in a plant where there are none too many hands to look after the various pieces of apparatus, the trap is liable to be neglected.

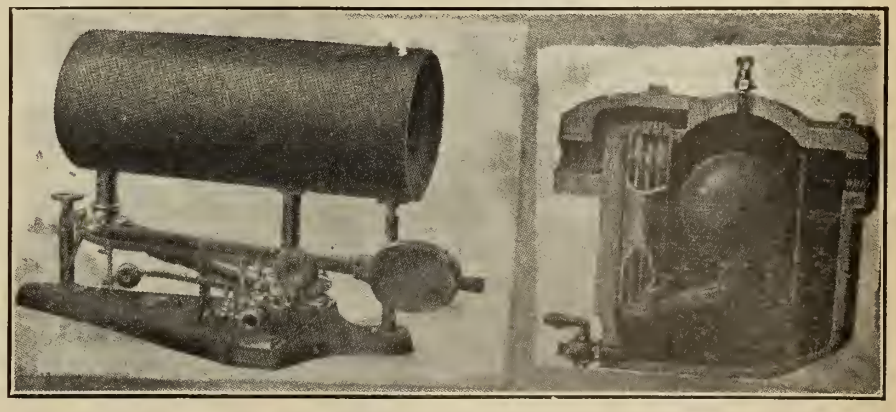
Considering first of all the traps that are purely for separating or draining purposes, that is traps that merely discharge the water collected to a hot well or to the drain, we usually find the ball float trap with needle valves controlling the discharge. Now there is not a great deal to keep in order on such a trap, but on the other hand, they are very quick to get out of order if neglected. There are generally in this type of trap a copper ball float, which is attached to a lever, a fulcrum point for this lever, and a fork joint at the end of the lever where the valve rods are fastened on. The valves themselves are of the needle point type, and are usually fitted at the bottom of the trap, although in some cases they are inverted and placed at the top of the trap. The possibilities of trouble in this type of trap are of a definite nature, easily watched. First of all the ball float may collapse, or become perforated, with the result that the trap will not operate at all. The various joints may become worn, so that it takes a much larger movement of the ball to produce the necessary valve opening. Thirdly, and by far the most frequent source of trouble, is the valve or valves being held open by small pieces of scale or dirt getting between them and their seats. This speedily results in cutting of the valves and their seats, and a continual leakage results. This type of trap should be examined at least once a month, if it is at all possible. Such traps are used on such positions as the drains from receiver coils on compound engines, where the steam coming to them may be oily, and the water only fit for discharge, cylinder drain cocks for the same reason, or in isolated places where it is not convenient to return the water to the hot well or heater. As a rule it is quite easy to see if these traps are functioning properly by having an opening fitted with a valve tapped onto the discharge pipe, in plain view. It is then only necessary to open this valve cock, and watch this operation for a few minutes. If a continuous feather of steam is noticed coming from the opening there is no doubt but that the trap is blowing steam through. If it is working properly, then a definite discharge of water for a period, followed by a period of no discharge, is observed. The temperature of the discharge pipe is a guide in some cases, though this is not a very good thing to go by, especially if the trap is on a high pressure line. Any trap that is discharging to a sewer or hot well, or better any trap that has an open discharge should be arranged so that the discharge pipe can be seen at any minute. The amount of steam that can be lost can be very easily calculated. The well known Napier's rule says that for steam over 60 lb. gross pressure, the weight of steam that can be discharged through orifice of one square inch, is in 70 seconds exactly equal to the gross pressure. Let us see what this means in figures. Suppose we have steam of 100 lb. gauge, or 115 lb. gross pressure per square inch, discharging into a one inch steam trap which is leaking, or allowing the steam to blow through. The probable amount of opening may easily be one half the area of the discharge. that is it would be equal to one quarter of a square inch. Now the rule in formula form is W or weight of steam is equal to

$$\frac{P \times A}{70}$$

lbs per second, where P is the gross pressure and A is the area of orifice. Substituting figures in the formula we have

$$\frac{115 \times .25}{70}$$

which gives .41 lb. per second, or 25 lb. per minute, 15,000 lb. per hour, or 36,000 lb. per day of 24 hours. If a pound of coal is evaporating 9 lb. of water, in 24 hours we can lose 4,000 lb. of coal through a leak of this kind. Did trap leakage ever occur to you in this particular way before? If not, it is easy to realise how a few little leaks on even ½ inch traps, can make themselves felt. Of course in a plant containing only one boiler, with a grate area of say 30 square feet, and a consumption of 12 lb. coal per square foot grate surface per hour for ten hours a day, say 3,600 lb. per 10 hours, and 400 lb. over the night period of banking, such a loss would cause instant action. Suppose instead, you have a plant con-



Tilting Trap and Ball Float Trap.

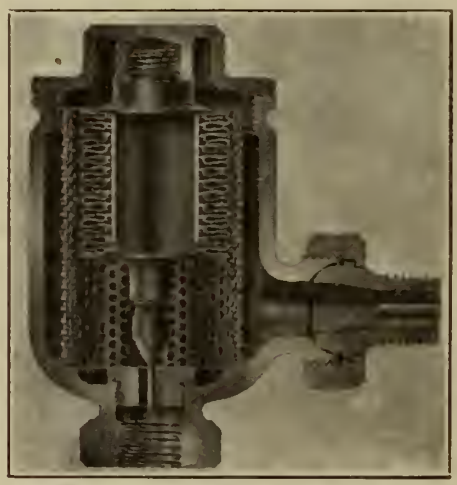
taining six boilers, with a grate surface of 30 square feet each boiler, and forced draught, burning 25 lb. coal per foot grate surface per hour, and running 24 hours. The normal consumption would be then 108,000 lb. per day. If it rose gradually to 112,000 lb. it would not be so easy to locate the trouble. Suppose in this same plant there are a dozen or more of these traps distributed around and there is a very small leak in three or four of them what will happen to the consumption?

Volatile Liquid Traps

Traps largely in use nowadays, especially on heating systems, for radiator purposes, are of the type that are operated by the expansion and contraction of a diaphragm containing a volatile liquid which is very quick to answer to changes in temperature. This liquid may be mercury, or some such substance, which has a definite and appreciable expansion per degree of temperature. The valve is fastened to the diaphragm, and is so arranged that when the liquid is heated up to the temperature of the steam which it is to control, that the valve will be pressed hard against the seat by the expansion of the liquid in the diaphragm. When this steam condenses, the liquid contracts, and the diaphragm closes together like a concertina, thus lifting the valve away from its seat. There is practically only one trouble likely to happen to this type of trap, and that is dirt getting on the seat and holding the valve open. They are usually constructed in such a way that there are no pockets around the seat to hold any obstruction, and the rush of water when the valve opens usually cleans off the seat. However, there is always a possibility of such a thing occurring, and it is well to have a look at these traps occasionally to make sure that everything is as it should be. If the engineer who is just starting up will only get into the way of systematically examining things whether they need it or not, he will save a lot of trouble for himself, for after all it is only by opening things up that he can find out how much they do need. Of course this thing can be carried to excess, but so can the habit of not examining things. We remember an old chief we sailed with some years ago, who used to say "She was all recht when she came in, and if you leave her alone, she will be all recht when she goes out." This reasoning had stood him in good stead for a good many years but it finally proved his undoing for on one voyage his low pressure piston fell to pieces on him when a few days out. There is a happy medium, and a man soon gets to know which parts of his particular plant need the most attention.

Tilting Traps

The return tilting trap is now in almost general use in power plant practice, and while there are a number of different makes, the general principle is the same. They consist essentially of a receiving drum, mounted on trunnions, that permit it to tilt up and down. The pipes leading into and away from the trap, are on the same line, and two check valves are employed to govern inlet and outlet. The trap when empty is usually in a horizontal position, and the water is led into the trap through the trunnion, the check valve opening to allow the water to come in. While this is going on, the discharge check valve is held shut by the boiler pressure acting against it. When the trap is filled with water, the weight causes it to tilt on its fulcrum, and as it does so, it opens automatically a valve which admits live steam onto the top of the water in the trap through the other side of the trunnion. This live steam pressure together with the weight of



Typical Trap of the Volatile Liquid Variety.

the water in the trap which is set some distance above the water level in the boiler, closes the check on the inlet pipe, and opens that on the discharge pipe against the boiler pressure, discharging the water into the boiler. When the trap is empty, a pivoted weight brings it back to the horizontal again, closing the steam valve at the same time.

The principle is simple, but unfortunately these traps have been the cause of great dissatisfaction to a good many, chiefly it is to be admitted, not through any fault of the traps, but for pure want of care and attention. Practically every trap has one weak point, and that is the trunnion. This part has a very hard duty to perform, and unless it is kept carefully packed, well lubricated, and evenly adjusted, it will leak badly, or else cause the trap to stick in one position or the other. When this sticking occurs, it is often the practice to interfere with the adjustment of the counter weight or weights, thus causing more complications, for every time the packing is adjusted the weight will also have to be adjusted. Uneven tightening up of the trunnion glands will cause sticking, while even tightening up if too much is given will cause the same thing. Return traps being situated on top of the boilers, are not in a position that tempts anyone to stay too long in their company, and the usual result is that when one gives a little trouble, which cannot be remedied right away, that the easiest way out is taken and the whole thing condemned. We wonder how many idle tilting traps there are in the Province of Ontario alone, representing money spent to no purpose, and each one a slur on the manufacturer, who is innocent. Although the steam valve gives trouble sometimes, due to the hard service it gets, the chief cause has been in our experience in the trunnion. We expect that every trap manufacturer will say that this is the case in all the other traps, not in his. However, if the trunnions are carefully and intelligently adjusted, and well looked after they will behave as well as most of the other special apparatus in the plant. Remember a machine of any kind is just a machine, and none of them can function without intelligent human care. Surely there should be no place where machinery could get more highly skilled attention than in a modern power house.

OTTAWA LODGE AGAIN

The Ottawa Lodge of the C.A.S.E. held another of their famous open meetings on Thursday Sept 22nd, in the hall of the Department of Trade and Commerce. As is usual when Ottawa Lodge holds an open meeting a large attendance of engineers and others turned up.

The lecture for the evening was delivered by Mr. Dickey of the C.Q. Dunham Co. of Toronto, and was illustrated by lantern slides. Mr. Dickey was very much at home in his subject, "Heating," and showed both how and how not to tackle the question of successfully heating a building. Besides the slides there were a couple of moving pictures, which were highly appreciated by all.

It is the experience of Ottawa Lodge that after every one of these open meetings there are quite a number of applications for membership. In fact so pronounced is this feature, that the members are alluding to the open meetings as revival meetings, so many come forward to remedy their past mistake of not being members of the C.A.S.E.

HAMILTON LODGE C. A. S. E.

At a recent meeting of the Hamilton Lodge, a lecture on the Jones Underfeed Stoker was given by the Executive Secretary Mr. L. J. Ellis, the slides being kindly loaned by the Under-Feed Stoker Co., of Canada. Brother A Bramham the president of the lodge, also assisted in the lecture, he being very conversant with the operation of the stoker, The Standard Underground Cable Co's plant, of which he is in charge, being equipped with them. A hearty vote of thanks was given to the Underfeed Stoker Co. for their courtesy in lending the films.

Some Notes on Magnetic Leakage

By TERRIL CROFT

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THERE is no known insulator for magnetism (lines of force). In dealing with electric currents we can direct them definitely by using conductors where we wish the current to flow and by interposing extremely poor conductors or insulators to prevent the electricity from flowing where we do not desire it. Fortunately, air is a splendid insulator of electricity. Unfortunately, in this respect, there is no very poor conductor or insulator for magnetism. Air is a fairly good conductor of magnetism, although it is not nearly as good as iron.

It follows then, that, even if an iron core has developed in it a flux of lines of force, there is likely to be some *leakage* of these lines through the surrounding air because the air has fairly low reluctance. An iron magnetic circuit surrounded by air is analogous to an uninsulated-copper electric circuit immersed in impure water. There would be some leakage of the electric current of such a circuit through the water just as there is some leakage of magnetic flux through the air. Because of this leakage all of the lines developed by the m.m.f. of a helix cannot always be confined to the iron of a magnetic circuit.

An example of magnetic leakage is shown in Fig. 1. A certain current is flowing around the helicies on the magnetic cores and produces a flux around the magnetic circuit. This picture indicates the principle of magnetic leakage but the values given are only illustrative and must not be taken as accurate or absolute—

Example.—At 1 the armature is held tightly against the poles, there is practically no leakage and a total flux of 9 lines circulates around the entire magnetic circuit. If the armature is pulled a short distance away from the poles, as at 11, the reluctance of the circuit is increased which decreases the flux to 7 lines and there is some leakage. As the armature is pulled further away, as at 111, the reluctance is still further increased reducing the flux to 6 lines and there is considerable leakage. If the armature is now entirely removed the reluctance of the magnetic circuit is very greatly increased because of the very large air gap, the total flux is thereby reduced to 5 lines and there is a great amount of leakage.

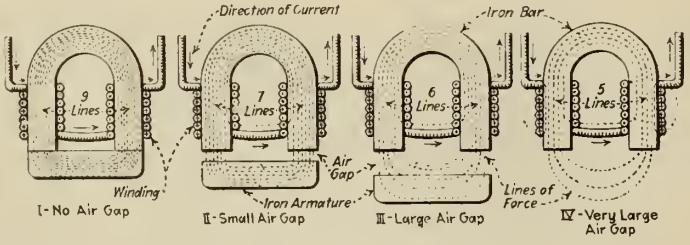


Fig. 1.—Illustrating Magnetic Leakage.

Examples of leakage lines in generators and motors are shown in Fig. 2.

Magnetic leakage can be practically eliminated by distributing the winding which develops the magnetomotive force uniformly around the magnetic circuit (Fig. 3,) this applies only where the reluctance is uniform along the entire length of the magnetic circuit. If the reluctance of certain portions of a circuit is different from that of other portions, the winding should be distributed along the portions of the circuit, each portion being provided with a part of the winding in proportion to its reluctance. That is, the portions of the circuit that have the greatest reluctances should have the greatest proportion of the amp. turns. The portions of the circuit that have little reluctance should be provided with correspondingly few amp. turns. In practice it is seldom possible to distribute a winding over the parts of a magnetic circuit in proportion to their reluctances but it should be done insofar as practicable.

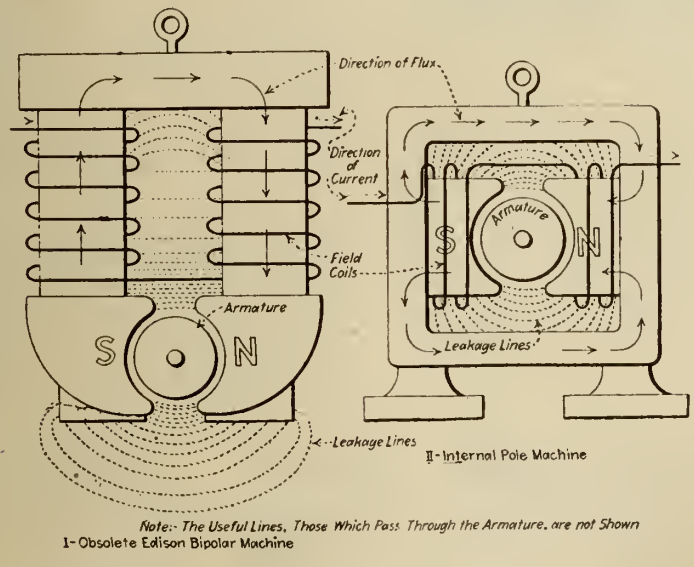


Fig. 2.—Leakage Lines of Generators and Motors.

Example.—Why it is that distributing the winding eliminates leakage will be evident from a study of Figs. 3 and 4 which show analogous electric and magnetic circuits. The electric circuits are immersed in a tank of water with a little acid in it, which renders the water conducting to electric currents. This is analogous to the usual condition of magnetic circuits which are always surrounded by air or by some other medium that is a fairly good conductor of magnetic flux. Now if the source of e.m.f. is concentrated as at 1 (Fig. 4), the maximum voltage developed, 8 volts in the case shown, is impressed across the copper electric circuit and the conducting liquid in parallel. The current due to this 8 volts will divide between the water and the copper paths in inverse proportion to their resistances in accordance with the law of divided circuits. Much more current will flow through the copper than through the water because the copper has, probably, much the lower resistance. However, some *leakage current* will flow through water as shown.

Current will flow through the water from locations in the copper ring of 1 which are at a high potential to those of a lower potential, as shown. The current that flows between any two locations will be proportional to the difference of potential—voltage—between the two locations. Evidently then the most current will flow through the water from one end of the copper ring to the other, at the points where the battery joins the ring and where the difference of potential is 8 volts. Obviously, if it were possible to so arrange

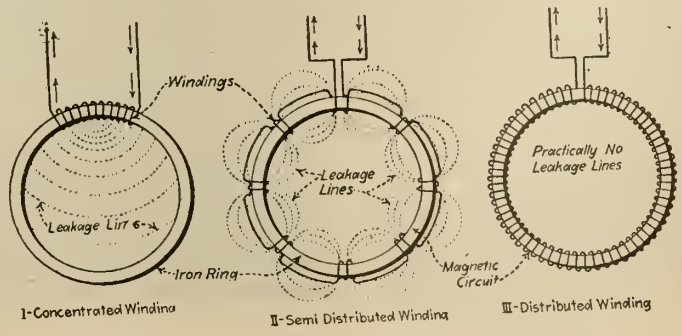


Fig. 3.—Leakage From Magnetic Circuit Surrounded by Air.

his submerged electric circuit that all locations in it would be at the same potential there would be no leakage currents through the water.

If the 8 cells are arranged around the circuit, as at Fig 8 11, the greatest possible difference of potential is 1 volt and the leakage currents are correspondingly reduced. However, by Ohm's law the same current is flowing through the copper conductor in 1 as in 11 because the total voltage impressed on the circuit is the same in both cases and the resistance is the same. Now if, as in 111, 16, 1-2 volt cells are uniformly arranged around the submerged electric circuit, the maximum difference of potential is reduced to 1-2 volt and the leakage currents are therefore practically eliminated nearly all the current will flow through the copper conductor. It is conceivable that a still greater number of cells, of correspondingly lower voltage, could be cut into the circuit and the maximum potential difference between any two locations in the circuit might thereby be reduced to practically O (zero) in which case of course, there could be no leakage currents through the water. In other words, if the cells that produce the e.m.f. were uniformly distributed around the electric circuit there could be no leakage currents.

A similar set of conditions obtains with the analogous magnetic circuit of Fig. 3. With the amp. turns concentrated as at 1 a large difference of magnetic potential form.m.f. is concentrated across the ends of the winding and there would be a correspond ingly great leakage. With the winding semi-distributed as at 11 the maximum possible difference of magnetic potential is reduced and the magnetic leakage is decreased accordingly, just as the maximum difference of electric potential was reduced in Fig. 4, 11. Now with a winding uniformly distributed as in 111, all parts of the magnetic circuit are at practically the same magnetic potential and there can be no magnetic leakage.

Therefore, where possible, the winding for developing a m.m.f. in a magnetic circuit should be so distributed that the m.m.f. will be consumed in that portion of the circuit where it is applied. Then there can be no leakage. Even with an air core, when a helix winding is uniformly distributed as in Fig. 5. 1, there is no appreciable leakage.

The computation of magnetic leakage is complicated and almost impossible in many cases because of the difficulty of determining the area of the path, of the magnetic circuit in air, that the leakage lines traverse. The lines spread out in passing through the air and how great or how small is the cross sectional area that they actually occupy cannot be readily estimated or calculated.

In practice, leakage is usually determined experimentally. A magnetic circuit having been built, its lekage or *leakage factor* can be ascertained by electrical and magnetic measurements.

The leakage factor of a magnetic circuit is the value by which the number of *useful* lines of force must be multiplied to ascertain the number of lines of force that must be developed by the amp. turns of the developing helix. That is, the leakage factor of a magnetic circuit is equal to the number of lines developed in the circuit divided by the number of useful lines of the circuit.

Example.— If, in the magnetic circuit of Fig 2. 1, it is necessary to design the field magnet coils to produce 140 lines of force for every 100 lines that are useful, that is, that pass through the armature, the leakage factor of that magnetic circuit is 1.4.

Leakage factor values vary with the arrangement and characteristics of a magnetic circuit. As a general proposition, the greater the pole piece surface exposed to the air the greater will be the leakage; see the illustration of Fig 6. In commercial generators and motors the leakage factor of the magnetic circuit may vary from 1.1 to 1.5. With modern machines, is probably varies between 1.1 and 1.3. Fig. 6 indicates approximate leakage factort for some typical magnetic circuits.

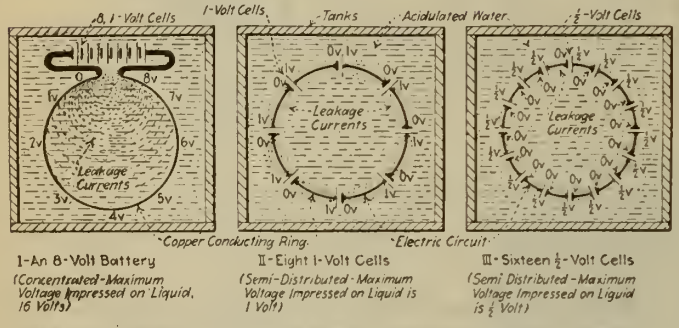


Fig. 4.—Leakage From a Magnetic Circuit Surrounded by Water.

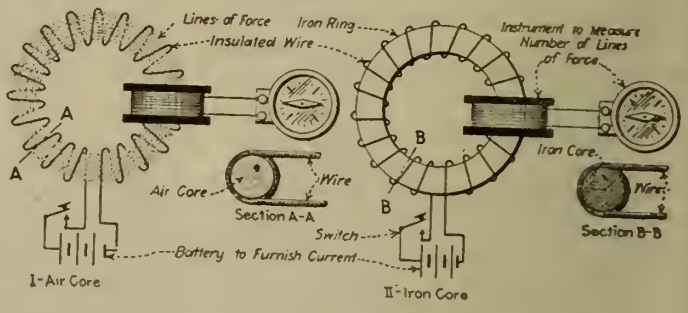


Fig. 5.—Arrangement for Determining Permeability of Iron.

In Power House of Sept 5 is an article describing an alleged boiler collapse and stating that an opportunity is provided for some readers to do a little thinking. I don't see why all readers should not do a little thinking or even much thinking, but no doubt the editor has reasons for placing the limitations.

In my opinion the drawing in of the head would be a perfectly natural result of a bag of the dimension and location of the one in question and would be due to the tension caused by the forming of the bag, and I don't see how any body but the owner of the boiler could call such a deformation a collapse R. McLaren.

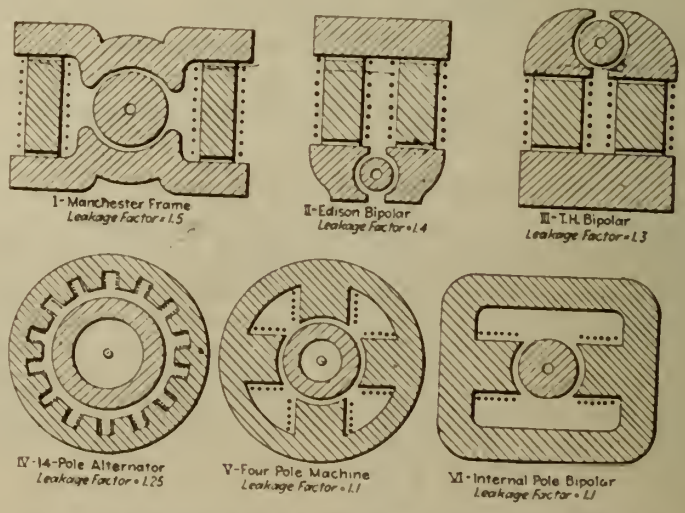


Fig. 6.—Leakage Factors of Magnetic Circuits of Electrical Machines.

Woodburn's Limited have been appointed sole Canadian representatives for a new electric resistance wire, which is being marketed among leading manufacturers of electrical appliances. Wiggam & Co., of Birmingham, are the manufacturers, and claim this was used for years in the British army.

Central Plant of the Acadia Coal Co.

The Boiler Plant and Boilers—Coal Handling at Power Plant—The Turbo Generators — Switchboards — Busbar Room — The Operation—As Seen by "Power House" Special Representative

J. A. McGILLIVRAY

THIS plant is one of the best equipped Colliery Power Plants in Nova Scotia. Built in 1911 with additions and improvements made in recent years, today represents an expenditure, for the Central Power Plant alone, of over $500,000.

With the installation of the power plant practically all the steam driven units at the Company's mines were replaced by electric drives. New bankheads were erected entirely of steel, replacing the old wooden structures. Fans, pumps, compressors, and hoists as well as bankhead equipment are now electric driven from central power plant, with one exception—the Allan shaft hoist, which is steam driven.

The following mines are served from the central station—Albion, MacGregor, Allan in Stellarton, and The Vale Colliery at Thorburn eight miles distant.

The Station generates at 3150 volts and this is stepped up to 13000 V for transmission to Thorburn Colliery.

Boiler Plant

The boiler room is built of brick with concrete foundation and concrete floors. The size of the building is 130 ft. x 78 ft. x 45 ft high to the eaves. The thickness of the walls being 20 in.

The foundations of the boilers extend from solid ground to the turbine floor. The flue or smoke box is constructed of concrete extending the full length of the building and terminating in a brick chimney. The chimney is built to a height of 140 feet above the grates and is 14 feet in diameter, constructed of brick, by the Custodis Company.

The Power Plant.

The boilers are arranged in five batteries of two boilers each, 10 in all, having a combined heating surface of 45,100 sq. ft. Six of the boilers are equipped with superheaters having a total superheating surface of 13,200 sq. ft. The boilers were furnished by the Babcock & Wilcox Company and are equipped with chain grate stokers—9 ft. wide by 12 ft. long, giving a grate surface of 108 sq. ft., or 41.8 sq. ft. of H.S. per sq. ft. of grate.

Steam is generated at a pressure of 150 lbs. per sq. in. though the boilers are built for a W.P. of 200 lbs. per sq. in. The amount of superheating is 207 deg. Fah. The superheaters have sufficient capacity to superheat to 300 deg. Fah., but it is found by experience in this plant that about 200 deg. Fah. is the most satisfactory as excessive superheat has been found to have a decided influence on the cost of upkeep.

The boiler feed pumps are located in a separate building adjacent to the boiler plant and consist of two standard Weir feed pumps, 13½ in. x 10 in. x 24in. stroke capacity each 85000 lbs. per hour against a 420 ft. head. One Lea Courtenay turbo feed pump, Terry turbine driven—this pump capacity is 159,360 lbs. per hour against a 420 ft. head and speed 2900 R.P.M. The steam consumption is 45 lbs. per B.H. P. Eff. 54%.

In this room is also located the feed water heater, Webster open type, capacity 4000 H.P. of water at 210 deg.

The condensed steam is metered at the heater by an Alburger Pump and Condenser Company's meter, having a capacity of 150,000 lbs. of water per hour. As the metering tanks dump they are recorded by a counter and also electrically recorded in the power house on a recording chart.

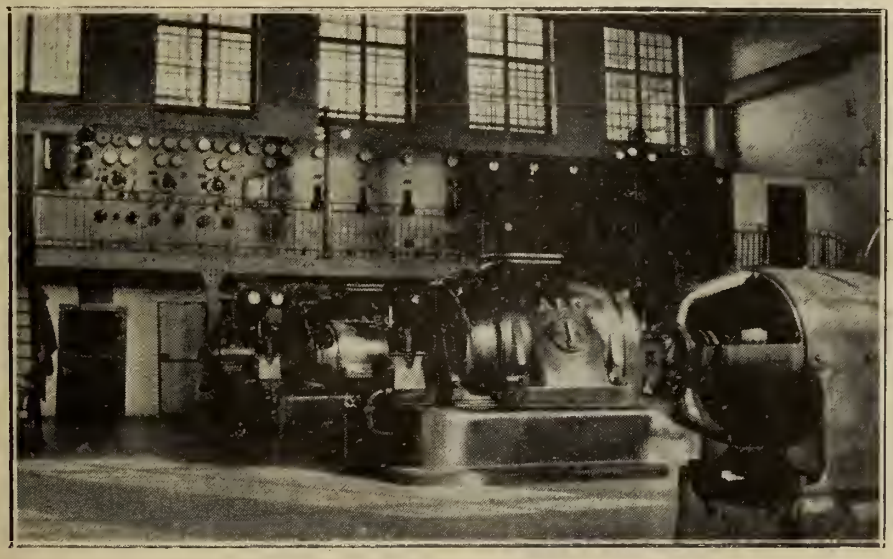
The supply of water to the boilers is made up of condensate from the condensers and the cooling water used on the turbines, additional made up from city mains when needed.

The feed water is heated by the exhaust from the auxiliaries, the average feed temperature being 93 deg. Cent. or 200 deg. Fah.

The water to boilers is measured by a Worthington hot water meter located in the feed line.

The boilers are fitted with recording draft gauges, Uehling automatic Co^2 graphic recorders and Uehling automatic hot gasses temperature recorders.

Coal is delivered by rail to private siding and dumped into a track hopper,



Direct Connected Exciters

from which it falls by gravity into a B. & W. tray conveyor delivering to a rotary automatic filler, which fills the buckets of the gravity bucket conveyor and is elevated over the bunkers. There is a coal crusher in the yard that crushes the coal into pieces not exceeding 2 in. cubes. (Normally low grade coal from the Company's mines is used for steam generation, the stokers and furnaces being adapted for low grade fuel.) The capacity of the coal handling apparatus is 40 tons per hour.

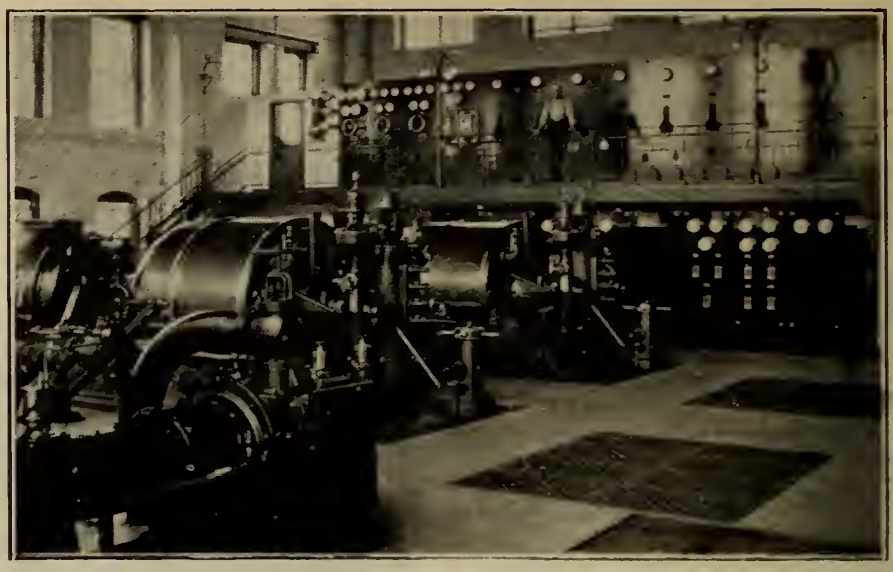
Ashes are flushed out by the overflow from the condensers into a valley.

The Turbo Generators

The turbines are located in a brick building 78 ft. x 62 ft. x 45 ft. high, separated from the boiler room by a brick wall. The building contains 3 turbo generators and their auxiliaries, one H. T. switch board, two L. T. switch boards, one air washer and humidifier, one 12 ton overhead "Miles" crane. The turbines are numbered 1, 2, and 3, and will be described in order.

No. 1. Built by the General Electric Company at Schenectady, N. Y., Curtis type having five pressure stages, capacity 5360 H.P. (4000 K.W.) speed R. P.M., steam pressure 150 lbs., gauge superheated to 207 deg. Fah. The full load steam consumption of this machine is 13.67 lbs. per K.W.H.at 150 lbs. per sq. in. (gauge) and 207 deg. Fah., half load 16.72 lbs. per K.W.H. The wheels are of nickel steel with special brass buckets, the first wheel having two rows of buckets. The diaphragms are cast iron with nickel steel nozzles.

There are three main bearings, the generator being coupled to the turbine by a solid coupling. The oil system contains 130 gals. of oil which is circulated through the bearings and governor under pressure as follows—thrust bearing 5 lbs. per sq. in., main bearing 25 lbs. per sq. in., governor 80 lbs. per sq. in. The normal temperature of the oil is 122 deg. Fah., at the receiving tank. The oil cooling system consists of a coil laid in the linings of the main bearings through which water is circulated. The packing glands on the main shaft



Generators and Switchboard

are of the labyrinth type, steam sealed.

The turbine is connected to the condenser by a multi-corrugated copper expansion joint. The condenser (a Worthington) placed directly below the turbine has a cooling surface of 7600 sq. ft. (1.9 sq. ft., per K.W.) The condenser tubes are of brass 18 B. W. G. with screwed ferrules on each end for packing. The water, both inlet and outlet, is 20 inch diameter. The atmosphere relief valve operates at 1 lb., back pressure.

The weight of the condenser when empty is 20 tons. The cooling water for condensing is supplied from the East River by motor driven centrifugal pump. A tunnel was driven from the East River to the power house, a distance of 780 ft. terminating in an under-ground pump-house, 34 feet below the power house basement. The water intake from the East River is 5 feet, 6 inches internal diameter.

In the underground pumphouse are located three centrifugal pumps to supply the turbines with condensing water. The delivery pipes are cross connected so that any condenser can be operated by any of the pumps. Provision is made to prevent flooding of the pump room at abnormally high tides. The overflow from the condensers is used for flushing the ashes from the ash pits. The ash channels are 18 inches deep and 36 inches wide, with a grade of 1½%. They are built of tile segments. The top of the channels are covered with wire screens of 2 inch mesh to prevent clinkers getting in before being broken up.

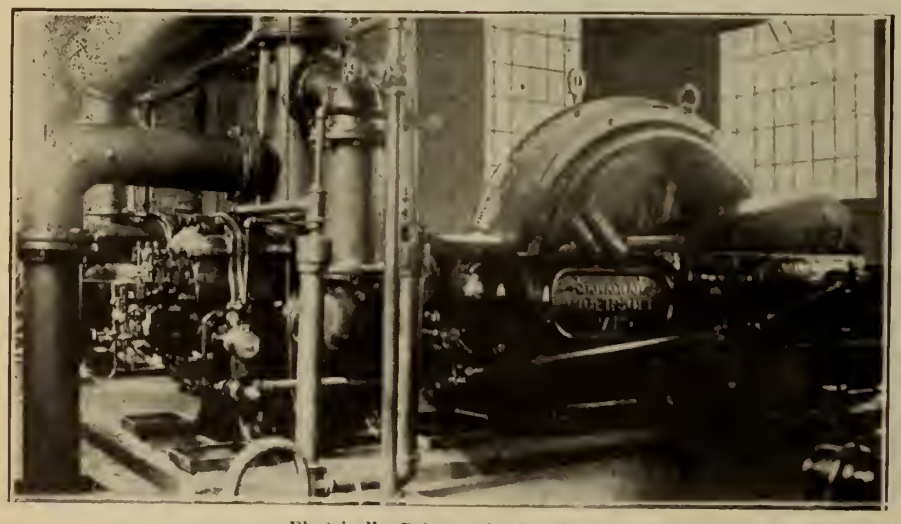
The condensate is pumped by a motor driven Worthington pump to the heater.

The dry vacuum pump is located on the turbine floor. The dimensions are 10 in. x 22 in. x 10 in. stroke and speed 100 R.P.M.

Turbines No. 2 and No. 3, differ in construction somewhat but operate under practically the same conditions as No. 1. Their capacity is 1875 K.V.A. each. They were built in Germany before the war, by A. E. G., Berlin. They are of the Curtis type, having nine pressure stages, besides the main admission valve which is controlled by the governor there are four auxiliary valves hand operated according to condition of load. They are of the four bearing type and have a forged steel elastic coupling running in oil.

The condensers are located directly under the turbines and have a cooling surface of 4250 sq. ft. (a little over 2 sq. ft per K.W.) The tubes are expanded in both heads.

The air pumps are a modification of the Edwards combined air and condensate pump. They are motor driven, the motors being of the slip ring type, with liquid starting resistance.



Electrically Driven Air Compressor

Generators

The Generators consist of one General Electric and two A.E.G., all three phase, 50 cycle, 3150 volts, 3000 R.P.M., with direct connected exciters.

Switch Boards

One H. T. 13 Panel Switch Board of black marble brought from Greece, Europe, serves the H. T. outgoing feeders and the transformer primaries. Each generator panel is equipped with the following instruments:

1 A. C. Voltmeter.

Nos. 1 and 2 Turbo Generators.

1 A. C. Ammeter.
1 A. C. Watt-meter.
1 Poly-phase integrating Watt-meter.
1 Demand recording Watt-meter.
1 D. C. Voltmeter (Excitation.)
1 D. C. Ammeter, (Excitation.)
2 indicating lamps for circuit breakers.
1 Frequency Meter.

The Generators are protected by circuit breakers, each fitted with two type B definite time limit relays, circuit opening type.

The Generator main switches are hand operated, oil breakers. The H. T. feeder circuits are protected by inverse time limit relays opening type.

The L. T. switch board consists of 12 panels, black marble and is used for local distribution at 550 volts, The L. H. feeders are protected by no voltage release fitted to the oil breakers.

The cooling air to the generators is washed by being passed through a Canadian Blower and Forge Company's carrier air washer, size 10 ft. 7¼ in. x 4 ft. x 10 in. with 80 sprays having a delivery of 144 gals. per minute. The velocity of the air through the washer is 500 feet per min. It is guaranteed that 98% of the solid matter carried by the air will be removed.

The station voltage regulation is obtained by G. E. voltage regulators.

The transformers are located in a brick building 31 ft. x 15 ft. x23 ft. high situated at the back of the power house. There are two Canadian General Electric step-up transformers 2?5 K. V. A. each, stepping up from 3150 to 11,000 for transmission to Thorburn Colliery. Two step-down transformers 350 K. V. A. each stepping down 3150 V to 525 having a full load eff. of 98%. Four 10 K. V. A. lighting transformers 525 V to 113 V.

All lines protected by Canadian General Electric graded shunt resistance multi-gap lightning arresters.

Busbar Room

The busbars are located in a room below the H. T. switchboard gallery 10 ft. wd. x 6¼ ft. high x 43 ft. long. There are two sets, (duplicates) of buses, oil breakers and isolating switches. The switches are placed in cells and are separated by concrete dividing walls. The busses being also separated by concrete wall. Throughout the whole electric system within the power house walls is carried out a color scheme so that any certain feeder, lead or earth connection can be located instantly at any point of the extensive system by referring to its color. The colors used are for the main generator leads, feeders, busbars and outgoing circuits—"red," "green" and "yellow" and "blue" for earths. Not only is this a convenience but adds to the beauty of the whole layout, the busbar room and cells being done in pure white.

There is also another feature worthy of note. There is a system of signal (bells) connected with the voltage regulator that rings an alarm to the engineer when there occurs an unusual disturbance of the line voltage.

The whole station is a thing of beauty,

Showing Low Tension Switchboard, and Alarm Signal Bells

as well as efficiency, not a speck of dirt, dust, oil or grease to be seen anywhere, and this at a pit mouth is the last thing one would expect.

The floor consists of special terrazzo flooring laid on re-enforced concrete. The floor, with its beautiful finish, and the black polished marble switchboard, with nickled instruments and nickled hand wheels for operating the oil breakers, the polished steel and brass mountings on the turbines, the bodies painted dead black, make a beautiful combination. The walls are white and the illumination at night is almost perfect. Not that there is an over abundance of lights but they are well placed and every part of the power house is a reflector.

Operation

In the generator room there is an engineer and assistant on duty eight hour shifts. Readings are logged every hour and averaged every shift. Reports are made in triplicate, one being filed in the power house, one sent to the chief electrician and one to the chief engineer.

In the boiler room there is on duty two men, a fireman and assistant, and one man in the pump room. Besides this there is one repair man and two cleaners, all under the supervision of the Combustion Engineer.

All repairs are made on the plant at the Company's machine shop, which is directly under the supervision of the Master Mechanic, Mr. W. Fraser.

TORONTO LODGE C. A. S. E.

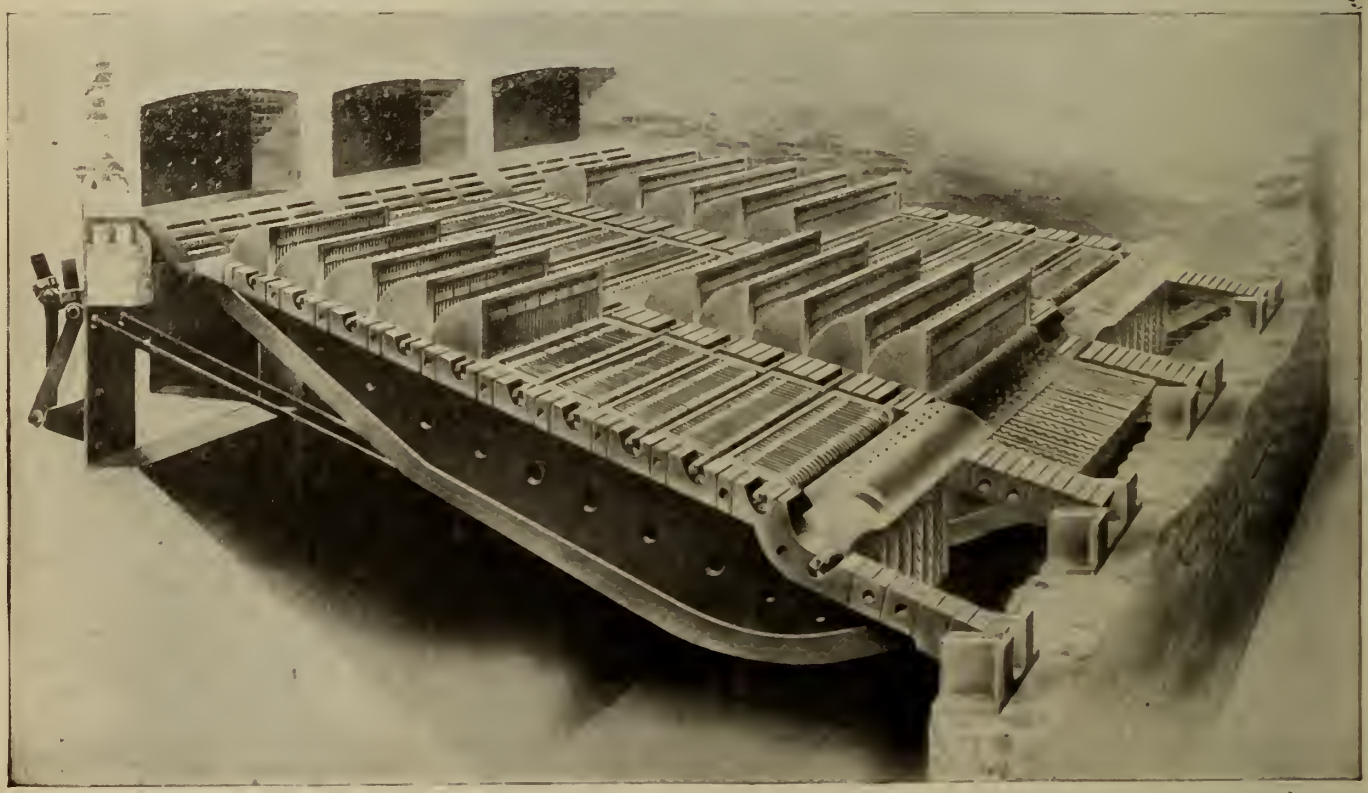
Toronto Lodge No. 1 C. A. S. E. are holding an open meetingto celebrate the opening of the new lodge room on Tuesday October 18 at 8 P. M. The entertainment will be held in the new room, which is situated in Cumberland Hall, Cumberland Street, the entrance being on Cumberland Street. The evening will be a guessing competition of an unusual sort. Invitations will be sent out, and a card accompanying them will contain space in which the guest will put down the number of guests who will be present in his opinion. The guess which comes nearest to the actual number will receive a very handsome prize.

With the removal to the new meeting place, which will be much more commodious and central than the old hall, the Toronto Lodge expects to get a largely increased membership, and with the live educational programme they expect to carry out, a most successful season is anticipated.

Messrs. Green Tweed & Co. New York have issued a circular describing their new brand of packing "Palco" which they are placing on the market. Palco has been designed for service on steam and hydraulic glands where the pressure does not exceed one hundred pounds per square inch and the element of very high temperature does not enter. It is a solid plaited packing thoroughly impregnated with graphite.

Files Stokers

Hand Operated



Simplicity—Ruggedness—Effectiveness—outstanding features of Files Stokers

Due to the absence of complicated and intricate parts, the average fireman is well able to operate the stoker with maximum efficiency—expert or expensive labor is unnecessary.

Clinker is ground out, ash and refuse removed, coal distributed—the fire is kept clean, uniform, rich—all by the easy, simple movement of the pull-rods at the boiler front. Not once are the fire doors opened to perform any of these operations. Cool air—that destroys draft, chills heated surfaces and strains the boiler—is eliminated.

Consult the perspective view of the stoker. It illustrates the distinctive movement of the stoker bars and the method of removing refuse by means of the counter-balanced cleaning plate. There is no drop in steam pressure nor is live coke lost into the ashpit during these operations.

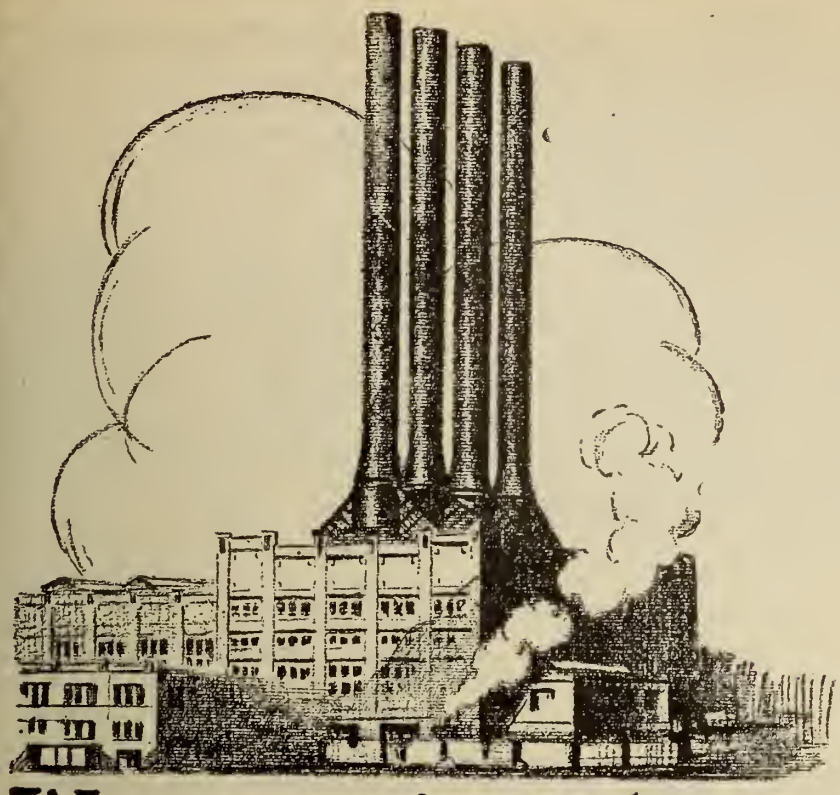
Perforations and corrugations throughout the various stoker parts provide constant circulation and proper distribution of air (absolute necessities for efficient combustion), and prevent warping or burning of these parts. Ample provision is made for expansion.

Combustion is complete at all times; maximum evaporation is guaranteed; overloads carried for long intervals are a natural requirement easily met by the stokers.

The entire stoker is designed simply but ruggedly; to insure continuous service with smallest operating and maintenance costs. Numerous plants — large and small—are benefiting from these exclusive features of Files Stokers.

Waterous

BRANTFORD, ONTARIO, CANADA



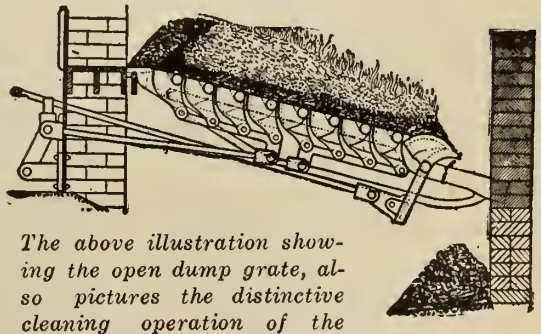
We are using six boilers now instead of eight

"Before purchasing your stokers, we operated eight boilers—we are using only six to-day. Files Stokers have so greatly increased our boiler efficiency that we are able to obtain sufficient steam from the six—the other two boilers are used as auxiliaries."

This is the way one client expresses the satisfaction derived from his stokers which are paying for themselves over and over again; they are enabling this concern to pocket the cost of operating two additional boilers. Yet the stokers are running on natural draft, burning 50% anthracite screenings! Instances such as these are not exceptional—they are the rule with Files Stokers.

Complete combustion, highest water evaporation, smoke elimination, continuously clean and fresh fires, are but a few of the direct results to be obtained.

Why not write us to-day for Bulletin "J" which contains all the interesting facts. There is no obligation.



The above illustration showing the open dump grate, also pictures the distinctive cleaning operation of the Stoker. This operation is easily performed without the necessity for opening the fire doors or without the loss of steam pressure. A single pull of the counter-balanced cleaning plate—that's all. Ash and clinker deposited on the plate are immediately dropped into the ashpit without the loss of any unburned fuel.

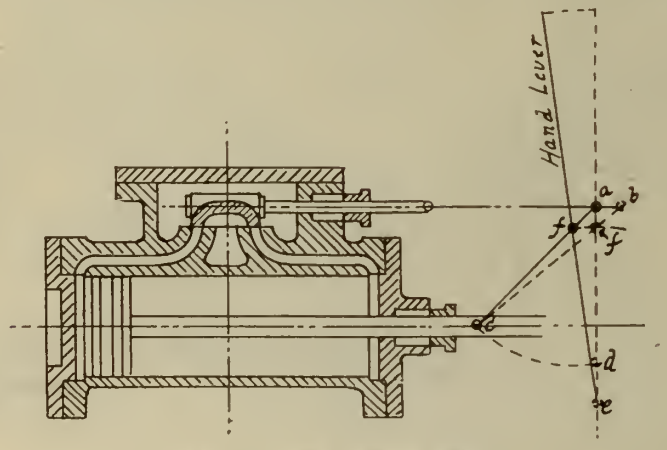
Waterous

BRANTFORD, ONTARIO, CANADA

A Lever Operating Engine

THE accompanying sketch shows a useful arrangement for operating by power, the levers of clutches, brakes etc. which require a greater force than can be conveniently got by means of a hand lever. These engines have been mainly used for reversing the link motions of large marine and hoisting engines, but there is no doubt, that if their principle was more widely known, they would be used more frequently, instead of the cumbersome systems of leverage which are necessary to get the force required down to that which can be exerted by an operator on a hand lever.

Referring to the drawing, the cylinder is a common steam engine cylinder, the only change to be made being that the slide valve has very little lap, the valve should for perfect action just cover the port openings, but for practical reasons it is necessary to have a little lap on the steam side, usually about a sixty-fourth to a thirty-second of an inch. The drawing shows a D slide valve, but a piston valve may be used instead if desired with the same results.



Design of Lever Operating Engine.

In operation the piston rod is attached to the lever or rod which is to be moved, by a pin connection or other suitable means, this connection is not shown in the drawing, as it will vary according to the work to be done. The control is by means of a hand lever, fulcrumed at any convenient point as e, and actuating another lever whose fulcrum pin is in the hand lever at f, which levers are for the sake of clarity indicated by center lines only in the drawing. The secondary lever is connected by links or other means to both piston rod and valve spindle. The piston is shown at the extreme end of its stroke, and when in this position the hand lever and secondary lever are in the positions indicated by the full lines. If the hand lever is now moved to its mid-stroke (vertical) position as indicated by the dotted lines, the secondary lever will be held stationery at one end by the piston rod, and its upper end will travel from a to b. This movement will draw the slide valve forward, and open the back port to steam causing the piston to travel forward.

As the piston advances it will carry with it the secondary lever, moving its lower end from c to d, and at this latter foint the upper end of the lever will have swung back to point a, and moved the slide valve back to its central position, closing the ports, and bringing the piston to rest at its mid-stroke, or precisely the position corresponding to that at which the hand lever has been set. If the piston becaus of the load against which it works, or through leakage of steam, should move in either direction from this central position, such movement of the piston rod will actuate the secondary lever and through it the valve spindle, and admit steam to the cylinder to arrest the movement, the action being to always hold the piston in the position indicated by the hand lever.

The power required at the hand lever is only that needed to overcome the friction of the slide valve, and the power that can be exerted by this engine may be whatever is required, being simply a matter of making the area of the cylinder sufficient to give the required power at the steam pressure available. The piston rod will move to any point in its stroke corresponding to the position of the hand lever, and maintain that position without further attention so long as the steam pressure is sufficient to overcome the resistance. The action in operating a brake is precisely the same as by hand, as any strain desired can be put on the brake from a slight pressure which can be gradually increased to the full pressure; or the full pressure may be suddenly thrown on, depending upon the manner in which the hand lever is operated.

The drawing gives only the general idea of the mechanism as the proportions will vary with the power to be exerted and the length of stroke desired, but its application to any given case is simple, as the parts themselves are simple, and the movements are easy to work out.

There is nothing about the mechanism to get out of order, and its upkeep cost is extremely low, much lower in actual experience than that of a system of levers which would exert the same force starting with that available on a hand lever. This because of the much smaller number of parts in the engine, the lever system having such a large number of pins and bearings that a little slack at each one soon totals up to such an extent of lost motion that the system fails to perform its functions unless kept in good repair.

In designing such an engine it is usual to cast the cylinder with a base for bolting to the floor, which base can be made to also carry the fulcrum bearing for the hand lever. Steam and exhaust connections to the steam chest are not shown on the drawing in order not to obscure the general idea, but must of course be provided for, as also drain cocks and lubricator.

The operating medium may be either steam or air, but if the latter is used, a piston fitted with cup-leathers is usually a better working proposition, than one fitted with rings, in fact if the engine is far enough away from the compressor to ensure always getting cool air, a solid piston if well fitted originally will give excellent results.

PULVERIZED COAL

Pulverized coal was first used in Portland cement industry, about forty-five years ago, as a fuel for heating the kilns in which the raw materials were burned. The experiment failed at that time, probably because the coal was not crushed finely enough. Methods and devices have since been developed, however, which have made it possible to use powdred coal as a fuel in many ways, and with great success. Some of the varied applications of pulverized coal, in addition to its use in cement manufacturing, are in connection with metallurgical furnaces, and for railroad-locomptive and stationary boilers. Wherever this fuel has been used under proper conditions, the results have been so satisfactory that there can be no doubt as to its value. A comparison of the costs of fuel oil, industrial (water) gas, and pulverized coal shows that, on a heat-unit basis pulverized coal is the cheapest.

Coal for pulverizing should be bituminous or semi-bituminous in character,—either run-of-mine or slack—and should preferably contain 30 per cent. or more of volatile matter. For ordinary uses, it should contain little or no sulphur. Recent experiments with anthracite and with inferior grades of bituminous coal, indicate that these will also give satisfactory results when properly manipulated, and that even anthracite culm, which has heretofore been considered of no value for pulverizing, may prove to be a suitable fuel.

In preparing pulverized coal it is first necessary to crush it to a size of about one inch. It is then carried by a belt conveyor to a magnetic separator, in order to remove any scrap iron or steel, which may be present in the coal, and which would cause trouble in the subsequent pulverizing process.

The next step consists in drying the coal until the moisture content is reduced to one per cent. or less. The first cost of the drying equipment is considerable, and for this reason undried coal has been used in a number of plants, and often with fairly satisfactory results. Moisture in the coal, however, is likely to cause trouble in the pulverizing operation by clogging up the machine; and in any event, the moisture must be removed before combustion can take place in the furnace. Hence, if the undried coal is used, the efficiency of the furnace is reduced to an extent depending on the amount of heat which is expended solely in evaporating the moisture in the coal. In addition, the temperature of the furnace is lowered considerably.

When dry, the coal is ground up to the requisite size in a pulverizing machine. There are several types of machines for this purpose, and the grinding is accomplished by the action of balls, rollers, hammers, or other mechanical devices. For satisfactory performance in the furnace the coal should be crushed so that about 85 per cent. of it will pass through

(Continued on Page 44)

Elements of Machine Design—Lesson No. 1

Forces in Machines—What is a Force?—Classification of Forces —Stress and Strain—Elasticity and Elastic Limit—Modulus of Elasticity—Resilience—Working Stress

*By L. T. RUTLEDGE, BA. Sc.

A MACHINE is a combination of resistant bodies or links, whose motions are completely constrained and whose links are so arranged as to transmit motion to some particular part where useful work is to be done. The transmission of this motion gives rise to forces which must be resisted by the various parts of the machine through which the forces are acting.

What is a Force?

A force is that cause which produces the following effects:—

(1) Change of motion or acceleration of a body.

(2) An opposition or balancing of other known forces.

(3) A measurable deflection or distortion in elastic bodies.

The first item relates to kinetics which is that branch of mechanics that treats of the movement of solid bodies produced by forces not in equilibrium, as in the case of machines.

The second item relates to problems in statics, which treat of the laws and conditions of forces acting upon solid bodies at rest, as in the case of bridges and buldings. A force is clearly defined when its point of application, magnitude and direction are known.

Classification of Forces

Forces acting upon machine parts may be classified as follows:—

(a) Useful forces—In doing useful work for which the machine was originally designed: for example, the parts of a drill press must transmit the forces produced by the resistance offered to the cutting tool by the material to be drilled.

(b) Dead weight forces—These forces are present due to the dead weight of the individual parts of the machine. In many designs these forces are overlooked but in many structures such as cranes, or heavy gear wheels on shafting they cannot be ignored. In structural steel work the dead weight or dead load is a very important item.

(c) Frictional forces.—Frictional forces are forces caused by friction between moving parts as in bearings or guides. Where these forces exist, provision must be made for the transmitting of the energy necessary to maintain the force.

(d) Forces due to expansion and contraction—In some structures such as boilers, steam pipes, etc., provision must be made for the forces of expansion and contraction caused by heat. In steam mains expansion joints are provided.

(e) Forces due to change in velocity—Where the direction of motion is constantly changing, as in a connecting rod, or where an acceleration exists, forces are present due to these causes. The design of a flywheel is very complicated on account of the centrifugal forces due to its motion of rotation.

Now it should be quite clear that the designer of a machine must make a careful analysis of all the forces acting from any cause whatever. These various forces should be listed so that all will be provided for. Failures are due to the neglect of this very point.

2:—Stress and Strain

In engineering problems, the external forces acting are usually spoken of as the loads. These loads, coming upon the members of a machine, causes the latter to undergo a deformation or change of shape which is known as the strain. The very instant the strain comes into existance, an internal resistance is set up by the molecules of the material to oppose the strain. As the strain increases, the resistance to it increases until a state of equilibrium is reached. The internal reaction is known as stress. So that the stress may be defined as the internal reaction against the external forces that cause a strain in the material. Forces and stresses are measured by the same units, namely, pounds or tons per square inch. Strain, which is really a stretch, an elongation, or a shortening up is measured, generally, in decimals of an inch.

The purpose of this series of articles, is to provide a short course in machine design, dealing with the fundamental principles involved in the design and operation of machinery. A definite and concise system of reasoning will be suggested for the solution of practical problems.

The course has been designed in the first place, to stimulate interest among any connected with mechanical work, especially such work as draughting, designing, superintending, inspecting, etc., and any who have not received a college or technical school education but who, nevertheless, are desirous of increasing their knowledge in this particular branch of engineering. Many who may have already studied mechanics and machine design will find it advantageous to do some reviewing.

*The author is Professor of Mechanical Engineering at Queen's University, Kingston, Ont., and should any reader wish help in any problem on mechanical matters, Mr. Rutledge will be only too pleased to offer assistance. To save time, write direct to Kingston, explaining your trouble in detail.

Elastic Limits and Modulii of Resilience in Tension.

Type of Steel		Elastic Limit	Modulus of Resilience
Open-hearth Carbon Steels	.08 per cent carbon	25000	10.4
	.15 " " "	30000	15.0
	.30 " " "	35000	20.4
	.40 " " "	41000	28.0
	.50 " " "	47500	37.6
	.60 " " "	63500	67.2
	.70 " " "	70500	82.8
	.80 " " "	75000	93.8
Alloy Steels	Nickel Steel 2.85% Ni — Annealed	52000	45.1
	Nickel Steel 2.85% Ni — Oil-tempered	121000	244.0
	Chrome Steel — Oil-tempered	127500	271.0
	Nickel Vanadium — "	126250	266.0
	Chrome Vanadium — Annealed	63.700	67.5
	Chrome Vanadium — Oil-tempered	170.000	482.0

Table 1.

The relationship between loads and stresses is very simple. If a pull of 3,000 lbs. is maintained on a fastened rod, then the stress in any cross section of the rod at right angles to the direction of the forces is 3,000 lbs. If the cross-sectional area of the rod is 3 sq. in. then the unit stress is 1,000 lbs. per sq. in.

Therefore, if "P" were the load acting on a member whose cross-sectional area is "A" then the unit stress "S" $= \frac{P}{A}$

When a body is stressed, there are always, at least, two forces acting. For example, consider a short post resting on a concrete block and let the post be loaded on the top with a weight of one ton. Where are the two forces? It is certain one of the forces is the weight on the post and the other must be the upward resistance of the concrete equal in magnitude to the downward force. If there were no opposing resistance the post would move downwards under the action of the weight and it would keep going till opposed. It is very important to realize fully that there must be, at least, two forces present for equilibrium.

Kinds of Stress

(a) Tensile stress or tension occurs when the opposing forces acting upon a body tend to pull it apart as in the tie bars of a bridge. Then the tensile stress is the internal molecular resistance, cohesion, etc., that acts to resist the separation of the material.

(b) Compressive stress or compression occurs when the opposing forces acting upon a body tend to compress or squeeze it and the particles of the body act to resist the crowding effect.

(c) Shearing stress or shear occurs when the opposing forces acting upon a body tend to cause one section to slide past another.

(d) Bending Stress, or bending, also called transverse stress is a combination of tension, compression and shear and is produced by loading a beam transversely. When the beam bends downwards the top fibres are in compression and the lower ones in tension. The load, in this case, tends to shear the beam in a vertical plane, the shear being maximum under the load. In addition, there is a horizontal shearing stress, brought about by the variation in the vertical shear and other conditions.

(3):—Elasticity and Elastic Limit

Elasticity is the property which a material possesses of returning to its original form and dimensions when the external forces causing distortion are removed. Steel is the most highly elastic material met with in practice. But within certain limits every solid body is elastic and the strain therein is directly proportional to the forces producing it. This is a statement of Hooke's Law. In other words the law states "that unit stress is proportional to unit strain."

The relation existing between the unit stress and unit strain for any material is best given by a diagram or curve, called the stress-strain diagram. The diagram is plotted from observations made when a test piece of the material is subjected to an increasing load and finally broken in a testing machine.

Where E_t = modulus of elasticity in tension

" S_t = unit stress in tension

" s = unit strain

Then $E_t = \frac{S_t}{s}$

Fig. 1 is a stress-strain diagram for a mild steel. The unit stresses in pounds per square inch are plotted as ordinates on the vertical axis, and the unit strain or strain per inch of length in thousandths of an inch. An inspection of the diagram shows how the steel behaves under load. It is seen that up to about 35,000 lbs. per square inch the diagram is a straight line, the unit stress being directly proportional to the unit strain.

At the point "B." the curve departs from the straight line. The behaviour of the beam of the testing machine indicates to the observer when this point is reached. The stress at the point "B." is called the elastic limit. It is the limiting point of perfect elasticity, that is, it is unit stress below which the strain disappears completely upon removal of the load or the elimination of the stress, or in other words, no permanent set can be detected. The point "C." is called the yield point and it is always quite close to the elastic limit. Beyond the point "C" the strain increases at a greater rate than the stress until finally rupture of the test piece occurs. The external load necessary to cause rupture divided by the original area of the cross-section of the bar is called the ultimate strength.

4:—Modulus of Elasticity

In order to determine the strain for any known load acting on a given material, it is very convenient to make use of a so-called modulus of elasticity. It is a factor obtained by dividing the unit stress by unit strain, the stress being not greater than the elastic limit. The value of this factor can, therefore, be obtained for any material from the straight line part of the stress-strain diagram. The slope of the line "A B" in Fig. 1 gives the value of the modulus of elasticity. The slope of a line is obtained by constructing a triangle, having the line as hypotenuse and having for the other two sides two lines, each parallel to an axis of the diagram, that is, have one vertical, and the other horizontal. Then the slope is given by dividing the opposite side by the adjacent. In trigonometry this ratio is called the tangent of an angle. Referring to the figure, the ration is B. D. A. D. Considering the case of mild steel it would be found that for unit stress of 30,000 lbs. per square inch the strain would be .001 per inch of length. Therefore the modulus of elasticity would be 30,000 divided by .001 or 30,000,000.

It is very important to know the modulus of elasticity for all metals and materials used in construction. It is a remarkable fact, however, that the modulus of elasticity of every steel is constant, or nearly so, no matter what the grade of the steel.

This is illustrated in Fig. 2. The diagram shows all the steels mentioned to have the same slope and the one straight line in the stress-strain diagram is common for all. Therefore the moduli of elasticity are equal and as was stated above, approximately 30,000,000 lbs. per square inch. The modulus of elasticity is a measure of the stiffness or rigidity of a material and since all grades of steel have approximately the same modulus of elasticity, it is apparent that a piece of soft, ordinary steel is just as stiff or rigid as the most expensive alloy steel of the same size and shape. So that, as far as stiffness is concerned and where strength is not considered and where the shock loads are not present, it is quite good enough to use a low-priced grade of mild steel.

5:—What Factors Determine Strength?

Though one grade of steel is as good as another as far as stiffness is concerned, it does not apply from the standpoint of strength. The quantities that determine strength are the elastic limit stress, the breaking stress, or ultimate stress, and the amount of maximum elongation possible. Table 1 gives the elastic limit for a few steels. The elastic limit of oil tempered chrome vanadium steel is 170,000 lbs. per square inch, which is five times that of machinery steel. The strength of a machine part not only depends on the strength of the material in it, but also on the shape and size of the section. This latter point shall be considered later.

6:—Resilience

Referring to the stress-strain diagram, it is evident that the area under the curve is the product of pounds and distance, the pounds being plotted vertically as stresses and the distances horizontally as strains. In mechanicsthe product pounds by distance, usually feet, is an expression for work or energy. Then the total area under the complete stress strain curve is the amount of energy required to rupture the material, while the area under the curve up to a certain point is the total work required to deform the material an amount equal to the deformation corresponding to the assumed point. If the assumed point be taken as the elastic limit, then the area

under that part of the diagram is the energy known as the resilience. This area in Fig. 1. is represented by the triangle A D B. Since the area of a triangle is one-half the product of the base and the perpendicular height or ½ (A D x D B), it follows

$$\text{That, Resilience} = \frac{1}{2}\left(A\,Se \times \frac{Se\,L}{Et}\right)$$

$$= \frac{AL\,Se^2}{2Et} \qquad (3)$$

In which A = cross-sectional area

Se = unit stress at the elastic limit

L = The length of the specimen

Et = modulus of elasticity in tension

Though the stress-strain diagram is plotted for test piece of unit dimensions, that is, 1 square inch in area and 1 inch long, multiplying by "A" and "L" converts it to suit the case of an actual bar.

However, if the specimen had a cross-section area of 1 square inch and a length of 1 inch, the symbols A and L will have disappeared from the equation (3) and the equation is reduced to

$$(2) \qquad \frac{Se^2}{2Et}$$

4:—This magnitude is the unit of resilience and is called the modulus of resilience. The modulus of resilience is very useful in mechanics of materials for comparing the capacity various materials have for resisting shock. Since the modulus of elasticity is practically constant for all grades of steel, it is seen that the capacity of two steels for resisting shocks varies directly as the squares of their stresses at the elastic limit. For example, the elastic limit of a certain machinery steel is 34,000 lbs. per square inch, and of oil-tempered chrome vanadium steel is 170,000 lbs, per square inch, the latter being five times the former. Then from equation (4), the capacity of the alloy steel for resisting shock is 5 squared or 25 times that of the machinery steel. This point relating to resistance against shock is a very important one for the designer to note.

7:—Working Stress and Factor of Safety

In general the maximum permissible stress induced in a machine member must be kept well below the elastic limit, so that the action of the load may be perfectly elastic. The stress used by the designer in determining the size of the part is known as the working stress. The number of times the ultimate strength contains the working stress is the factors of safety. The size of this factor varies from 4 to 29 with conditions, some of which are listed below. In the case of cast iron, which is brittle and which often has blow holes and bad spots, it is customary to use a high factor of safety, whereas steel which is very ductile and more uniform in structure admits of the use of a smaller factor of safety.

The magnitude of the working stress depends on the following conditions:

(a) Kind of material, quality of it, its chemical composition, elastic limit, ultimate strength, resilience, elongation properties.

(b) Is the application of the load steady or variable, and if variable, does it vary from zero to a positive maximum or from a positive maximum to a negative maximum?

(c) Is the part subject to shock loads?

(d) Is the stress produced from the application of the load a simple stress or a compound one and what kind of stress is produced?

(e) Is the material used in the construction reliable and all the same as the sample tested?

(f) Is the material of the machine part subjected to unnecessary and speedy deterioration?

(g) Cost of manufacturing.

(h) The demand on the machine at some future date.

(i) Is human life or property endangered in case any part of the machine fails?

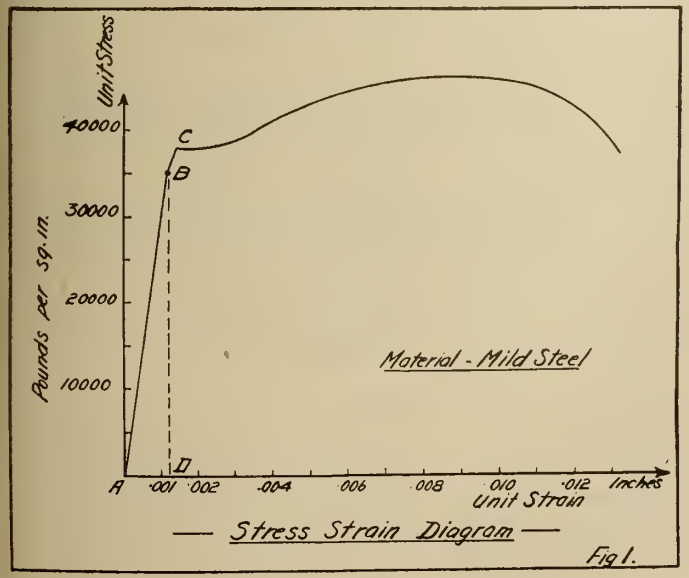
(j) Is the machine to be designed to do a certain work for a short time only and then be scrapped, or is it to be a part of a permanent equipment.

(k) Have temperature stresses to be considered?

OIL FUEL IN 1921

Lloyd's "Register of Shipping" gives the following interesting information in reference to the use of Oil Fuel for ships. In 1914 there were 364 steamers of 1,310,000 tons fitted for burning oil fuel, whereas at present there are 2,536 such vessels of 12,797,000 tons, the amount being more than nine times larger than that of 1914.

The percentage of total gross tonnage using oil, etc., in internal-combustion engines in 1914 was 0.47 and in 1921, 2.0. The percentage using oil fuel for boilers was 2.62 in 1914 and 20.65 in 1921.



— Stress Strain Diagram —

Fig 1.

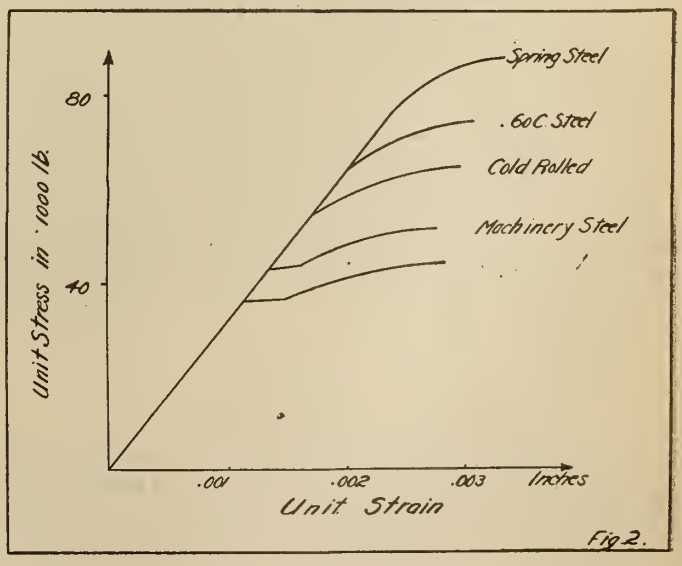


Fig 2.

Member of the Audit Bureau of Circulation

POWER HOUSE

OCTOBER 5th, 1921.

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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H. A. WILSON, - Resident Editor, Montreal
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Heat and Temperature

THE two words heat and temperature seem to be responsible for a lot of misunderstanding among men who should know perfectly well just what they mean. To the steam engineer it is absolutely necessary that his mind should be clear as to the difference between heat and temperature if he is to understand properly the principles of his work. Probably a good deal of the misconception arises through our use of the terms hot and cold to indicate slight differences of temperature that are apparent to our senses. Thus we speak of ice as being cold, and boiling water as being hot, by which we mean that there is a difference of temperature between them which is easily seen. However, if we consider their relative temperature as measured from the absolute zero of temperature the difference is seen to be much less than when we consider the mere thermometer range of temperature. Thus ice at 32 degrees by the thermometer, is at an absolute temperature of 492 degrees, while water when boiling is at an absolute temperature of 672. When we consider the heat contained in a quantity of water at different temperatures we have to consider not only the heat that is shown by the thermometer, but also the heat that has been put into the water to change it from the state of ice to that of water, and which heat is not shown by any method of measurement. That is the familiar latent heat. If the engineer can divorce in his mind temperature and heat, and get a true idea of each, he will find many problems much simplified. Suppose it were possible to reach the absolute zero of temperature, which has not yet been achieved, we would have a state where there was no heat of any kind and no temperature. Now if we had one pound of water at just one degree above absolute zero, we would have a definite quantity of heat, that is, I.B.T.U. Now, if we increase the amount of water to 1000 pounds at the same temperature we should have a quantity of heat equal to 1000 B.T.U. approximately, that is more heat than is required to change a pound of water at boiling point into a pound of steam at boiling point. Of course we could not have a pound of water at any such temperature, but this is merely used as an illustration. Large amounts of heat can exist at very low levels of temperature, but unfortunately it is necessary for us to utilise our heat resources at high levels of temperature in the heat engine as we know it.

Strong For Education

THE National Association of Stationary Engineers, which is the United States body of stationary engineers, have been holding their annual convention at Evansville, Ind. This probably has not much interest to the Canadian engineer, but the actions of a body composed of 19,000 members is worth looking at, anyway. The thing that stands out from this convention is the great stress laid on the educational activities of the Association, and the practical interest shown in this subject. For instance, it was urged that the educational work should be carried along as in the past, that it be made more effective, and that the board of directors consider the appointment of a permanent salaried educational secretary. Another point urged was that there should be close co-operation between the local and state associations and the engineering schools of the respective states. In this connection, it was stated that in Indiana, the engineers had the services of no less than thirty-six specialists for lectures on subjects of interest to them in their profession. This seems to us an excellent idea, and one worth the attention of stationary engineers' societies in Canada. We have not the least doubt that if the matter was properly approached, it would be possible to get the services of professors of engineering to deliver lectures to the members of these societies, on any subject that the latter would wish. Such lectures, if obtained say once a month during the winter, would be of the greatest possible value, and being presented by men whose occupation is that of imparting knowledge, there would be no doubt of the clarity of their exposition. This seems to be worthy of consideration by those who have the interest of the engineer at heart.

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Progress in New Equipment

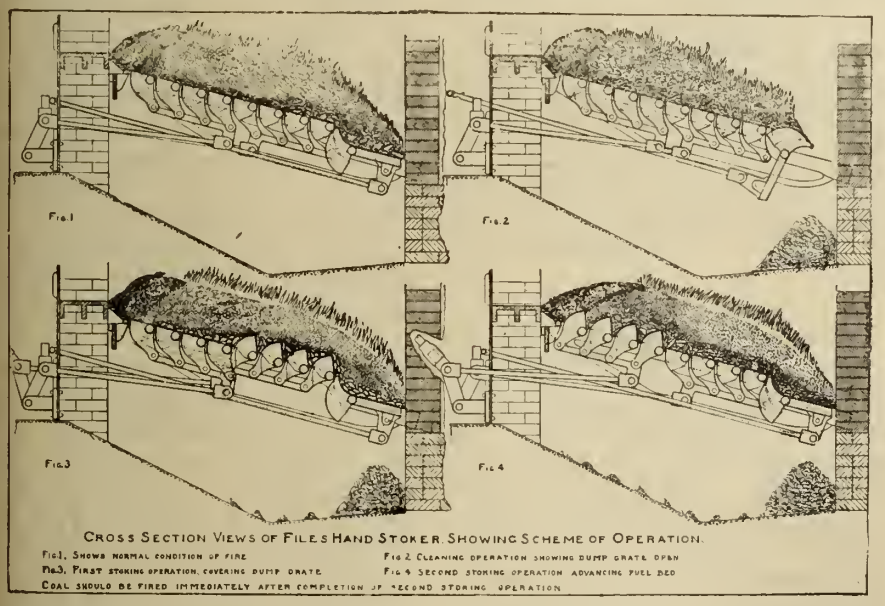
THE FILES STOKER

Although the Files Stoker has been in use in the United States for some time, it is just now being introduced into Canada by the Waterous Engine Works Company, Limited of Brantford.

The Stoker is designed to overcome the many defects and losses occasioned by the ordinary hand firing and cleaning and to meet the requirements of complete and efficient combustion viz: a correct proportion and distribution of air, a clean fire continuously maintained, and an even thickness of fuel bed in proportion to draft conditions and load.

Operation of the Stoker

The Stoker is of the overfeed type and the fire is under observation at all times.



CROSS SECTION VIEWS OF FILES HAND STOKER SHOWING SCHEME OF OPERATION.

Fig1. Shows normal condition of fire. Fig 2. Cleaning operation showing dump grate open.
Fig3. First stoking operation, covering dump grate. Fig 4 Second stoking operation advancing fuel bed.
Coal should be fired immediately after completion of second stoking operation.

Coal is coked on a coking plate and the foremost stoker bars, where the gases are driven off and properly consumed in their passage over the hot, incandescent fire bed.

The coked coal is gradually worked down the inclined surface of the stoker by the simple operation of the stoker bar handles situated at the boiler front.

This operation actuates the stoker bars vertically six inches into the fire, breaking up the ash and clinker formation and pushing it forward to the cleaning plate, at the same time advancing the unburned fuel toward the rear of the furnace and producing a condition whereby a free passage of air is obtainable throughout the entire fuel bed.

A single pull of the counterbalanced cleaning plate drops the ash into the ashpit without the loss of unburned coal or drop in steam pressure, and without entailing the extreme exertion on the part of the fireman required in cleaning the ordinary flat grate fire. This latter operation, necessary only at occasional intervals, is easily and instantly performed.

The result is a test fire condition at all times—free of ash and clinker, producing the highest and most efficient combustion to be desired.

It is claimed that these stokers can be easily installed at slight cost in a few days or over a week end. No alterations to boiler fronts are necessary other than drilling a few holes for positioning the operating levers, and when complete there are no changes in settings or objectionable projections and the boiler fronts are not defaced.

The makers state that all grades of bituminous coal, heavy mixtures of anthracite, culm or screenings mixed with bituminous coal or mixtures of coke and similar fuels, can be used with excellent results with the Files Hand Stokers, and that cheaper and poorer grades of fuel can be used with higher efficiency than is possible with better grades of coal on ordinary grates.

The flexibility of the shaking grate is combined with the advantages of stoker operation by which coal—high in ash and refuse,—is permitted to burn without causing the fire to become dirty or preventing the highest possible efficiency and capacity.

A saving in labor due to the installation of the Files Hand Stokers is effected over that required with ordinary grates.

When installed with proper settings, Files Stokers will, it is claimed, give absolutely smokeless combustion with any fuel. This is due to the same causes which make possible the increased efficiency of stoker-fired boilers as compared with that of hand-fired boilers; namely; rapid disposal of ash and clinker; a thorough cleaning of fires without disturbing the active fires; and an even bed of fuel at all times.

BRITISH ENGINEERING TRIUMPHS

Mechanical engineering is the very best basis of modern civilization, writes D. A. Bremner, O. B. E., director of the British Engineers' Association, in an article reviewing British achievement in this branch. Great Britain was the birth place, and for many decades the chief seat of mechanical engineering no matter how loud the boasts of persons across the Rhine. What is more the British set a high standard of excellence and reliability and this has resulted in a world-wide reputation for the products of their inventive genius and skill.

The basic invention was the steam engine in which Thomas Savery, 1698, and Thomas Newcomen, 1772, were the pioneers, although the achievement belongs to James Watt, 1736-1819. Four other British engineers developed the high speed steam engine, and then another series of great men perfected the marine engine, John Penn, and A. C. Kirk introduced the triple expansion engine. The reaction steam-turbine, which revolutionized marine propulsion and electric power generation, was invented by Sir Charles Parsons in 1844, and the condensing type of turbine in 1891. Eight great names, commencing with Brindley, 1756, are associated with the steam boiler. Stephanson, Webb and Worsdell created the locomotive.

Progress with any of these inventions would have been impossible without machine tools, and in their invention and development the British record is unique.

Large drilling machines and lathes were first made by Boulton and Watt at the end of the eighteenth century. The lathe slide-rest with leading screw and change wheels was invented by Henry Maudsley in 1800, the self-acting lathe by Sir Joseph Whitworth in 1835, the steam hammer by James Nasmyth in 1839, the planing machine by Richard Roberts in 1817, and the self acting planing machine by Sir Joseph Whitworth in 1835. Milling cutters or hobs for cutting toothed wheels and worm gears were invented by R. Bodmer in 1839, the shearing machine by G. B. Thornycroft in 1843. Sir Joseph Whitworth's screw stocks, dies and taps were patented in 1840. Composition emry grinding wheels by D. Fisher in 1856. Hydraulic machinery is associated the world over with the names of Lord Armstrong, R. H. Twedell, Fielding, J. and J. Platt, the last mentioned of whom invented hydraulic forging in 1885.

The construction of accurate machine tools, and the production of accurate work, either by machinery or hand processes, would have been impracticable without the use of surface plates. Sir Joseph Whitworth's method of producing such truly plane surfaces which he devised in 1840, was, therefore, a discovery of the first importance. The same may be said of his measuring instruments of unprecedented precision.

Since the time briefly chronicled above, up to the present day, British mechanical engineers have proved themselves worthy of their distinguished forefathers. The developments have, however, been so vast that it is impossible even to mention them here. The

recent world's record performances of British aircraft are fresh in the memories of all. The representative Britsh motor-car de luxe is universally conceded to stand in a class by itself. The Mitchell thrust block and bearing, a British invention, embodies a new principle of construction revolutionizing all preconceptions in regard to lubrication and the pressures sustainable by rubbing surfaces.

Reference may also be made to the valuable work done by the Britsh Engineering Standards' Association and the National Physical Laboratory, the benefits of which are not confined to Britain.

THE TRUSCOTT HIGH SPEED ENGINE

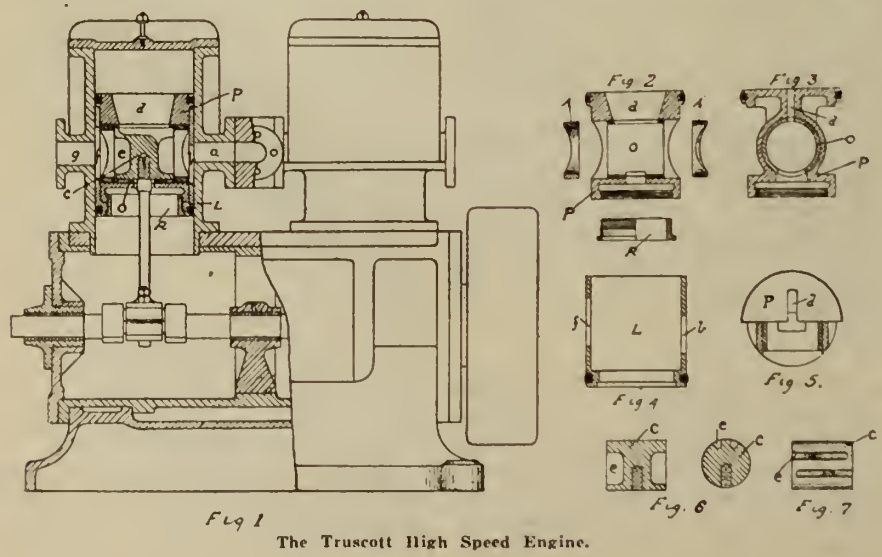
The Truscott patent engine is single acting, with twin cylinders, having cranks at 180 degs., and is for steam. The use of the term "steam" is intended to include other working fluids also. In the accompanying drawings, Fig. 1 shows an elevation of the engine partly in section, the piston having travelled through half its working stroke. Figs. 2, 3, and 5 show sectional and part sectional views of the piston body P, in the form of a light casting, with the port D preferably cored in position. The casting P, Fig. 2, is bored to take the liner O, together with the rings A and A1, a slot being provided of sufficient length to allow working clearance for the connecting rod, the said slot being situated in the manner shown, with reference to Figs. 1, 2, 3, and 5. The base of the piston body P is further screwed internally to receive the ring R, which is provided with a similar thread.

Fig. 4 shows a sectional view of the piston liner L, taken through the ports B and F. The liner L is turned a working fit to the bore of the cylinder, and bored to receive the piston body P, being further recessed to engage with the ring R.

Fig. 6 shows vertical sections of the gudgeon pin C the cavity E communicating with a port extending in line with the axis of the said pin, and situated on its periphery, this port being for exhaust. A similar port and cavity is provided for the inlet, being placed on the opposite side as shown. The pin C is bored and screwed to receive the connecting rod and turned a working fit to the bore of the liner O.

Fig. 7 shows an external view of the gudgeon pin C, in plan, showing the inlet and exhaust port E. Taking one cylinder only, the cycle of operations is as follows:—Commencing with the piston on the top dead centre, steam is admitted to the central chamber between the cylinders and flows through the passage A whence it passes through the piston liner L through the port B into the gudgeon pin C finally reaching the cylinder by the port D in the piston. The port in the gudgeon pin C is arranged for admitting steam to the top of the piston, with a slight lead, when on the top dead centre. The piston is thus forced down and steam is cut off when the top edge of the port B in the piston liner L is opposite the bottom edge of the port A in the cylinder wall. Expansion takes place until the bottom dead centre is reached, which brings the gudgeon pin central. Exhaust commences on the up stroke through the port E in the gudgeon pin C the steam finally escaping through the ports F and G in the piston liner and cylinder wall respectively, and thus to atmosphere.

The Anti Corrosion Engineering Co of New York, have issued a little pamphlet entitled "Water That Won't Rust" describing the method the company uses to make water harmless before it enters hot water tanks or boilers. The process is not in any manner in the nature of a boiler compound, but is a process of de-activation and de-aeration, which renders the water incapable of oxidising or rusting the material it comes in contact with the metal of the tank or pipes. It is claimed that with this process in use steel pipes can be made to last longer than brass pipes.



The Truscott High Speed Engine.

NATIONAL ASSOCIATION OF PRACTICAL REFRIGERATING ENGINEERS

The twelfth annual convention of th National Association of Practical Re frigerating Engineers will be held a Hotel Lorraine, Philadelphia, Pa., o November 30, and December 1, 2 and 1921. This is the first meeting of th Association to be held in the East, an it is confidently expected that it wi eclipse any previous gathering of refri erating engineers, even the successf convention which the Association held Chicago last December.

The gratifying growth of the Associ tion during the past few years, with i membership representing every sectio and almost every state in the Unio makes it reasonable to expect a reco attendance, and anticipating this th committee in charge of the conventio arrangements are making preparatio on a greater scale than ever before.

The program to be provided will i clude papers by men of world-wide r putation, who are being chosen becau of their familiarity with the particul subjects in which the membership, an refrigerating engineers in general, a interested. Also, there will be pape of interest to all groups of the refrige ating industry, including the employ and managers who will be welcome attend as visitors. Each year is sho ing an increase in the number of pla owners and plant managers who atte the sessions of the convention. Th are commencing to realize that duri the few short days the convention is session they can obtain valuable info mation as to plant operation. Along th same line of reasoning, many employe are making a practice of sending the engineers to these annual meetin They have learned that it is a good i vestment.

The Educational and Examini Board of the National Asociation Practical Refrigerating Engineers h recently had prepared under its supe vision a Lecture Course on "The Pri ciples of Refrigeration," in twenty par for the benefit of its members. Sta ing with Lecture No. 1, the Course sent to them at intervals of two week It is the most valuable work on that i portant subject thus far contribute and the Board is to be highly commen ed upon the results of its efforts.

Refrigerating engineers who are n now members of the Association wou do well to write the National Secretar Mr. Edward H. Fox, 5707 West La St. Chicago, for information, with t view of joining and availing themselv of the educational work it is carryi on, including the Lecture Course.

PATENT BOILER ALARM

To all whom it may concern:

Be it known that I, John J. Hines, a citizen of the Dominion of Canada, residing at Halifax, in the Province of Nova Scotia and Dominion of Canada, have invented new and useful improvements in Boiler Alarms, of which the following is a specification.

My present invention pertains to boiler alarms; and it contemplates the provision of a simple, inexpensively installed and reliable apparatus, calculated in the event of the water in a boiler getting dangerously low to apprise the engineer of the fact so that he can have the boiler supplied with water before any damage takes place.

The apparatus is designed more particularly for use on a marine boiler and will be fully understood from the following description and claims, when the same are read in connection with the drawing, accompanying and forming part of this specification, in which:

Figure 1 is a view diagrammatic in character and showing the application of my apparatus to a marine boiler, and also showing that when a vessel is rolling or pitching in a heavy seaway there is practically no rise and fall of water in the center of the boiler where my novel apparatus is preferably located, particularly when the apparatus is used on a marine boiler.

Figure 2 is an enlarged vertical section of my novel apparatus.

Figure 3 is an enlarged view, partly in elevation and partly in vertical section showing the upper portion of the apparatus.

Similar numerals of reference designate corresponding parts in all of the views of the drawings.

The boiler 1 may be of any type, and in furtherance of my invention, a pipe 3, preferably of iron, and a column 2, preferably of brass, are connected with the boiler shell, the connections being effected, in the preferred embodiment of the invention, through the medium of a sandwich joint as best shown in Figure. 2, the said joint including flanges 4 and suitable connecting means 5.

When employed in a marine boiler, as in Figure 1, the pipe 3 extends downwardly through the steam and water space to the danger level of the boiler—i. e., about one inch above the highest heating surfaces, and I would also have it understood that the preferred arrangement of the pipe 3 is in the center of the boiler perpendicularly and longitudinally, this in order that the portion of the water adjacent to the lower end of the pipe will not be materially effected by movement of the ship.

The column 2 extends above and outside the boiler shell so as to radiate heat from the water contained in the column into the atmosphere, and in order to increase the radiating surface of the column, which is hollow, the said column is made in convolute form as illustrated.

The upper end of the column 2 is flanged, as indicated by 7, and to said flange 7 is connected by bolts 12 or other suitable means a closure plate 8.

At 17 is a container, preferably of copper, and in the said container is a mass 22 of mercury or equivalent material. The upper portion of the container, which upper portion is numbered 14, in Figures 2 and 3, is carried through the plate 8 and a gland 13 thereon, and may, when deemed necessary be insulated from the said plate and gland.

At 15 in the upper end of the container 14 is a plug of insulating material which is preferably threaded into an enlarged portion of the container as indicated by 16, and screwed in the said plug 15 is a terminal 19 designed to be connected with the plus pole of a source of electric energy (not shown). At 18, and bearing in the container 14 and contacting with the mercury is a complementary terminal designed to be electrically connected with the alarm or alarms (not shown) through the medium of which the engineer and other persons in authority are put on notice when the water in the boiler is dangerously low.

Under normal conditions, the boiler pressure operates to force water up the pipe 3 so as to flood the column 2 which, as before stated, is outside the boiler. This water being stagnant and in a column adapted to radiate heat into the atmosphere, it follows that such water will be considerably cooler than the water within the boiler, and consequently the heat given off by such water will not operate to expand the mercury 22 to any material extent. In the event, however, of the water in the boiler falling below the end of the pipe 3, the said pipe 3 and the column 2 will be immediately occupied by steam of high temperature, and in consequence the mercury will be quickly expanded and caused to electrically connect the terminals 18 and 19 whereupon the alarm or alarms will be sounded.

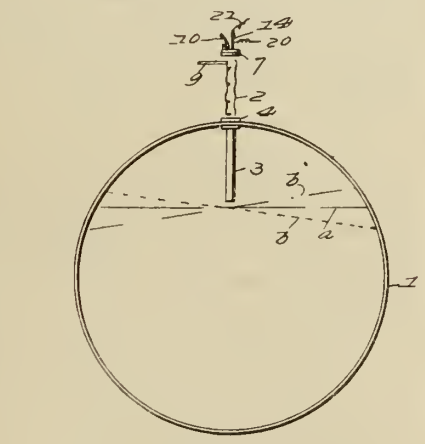


Fig. 1.

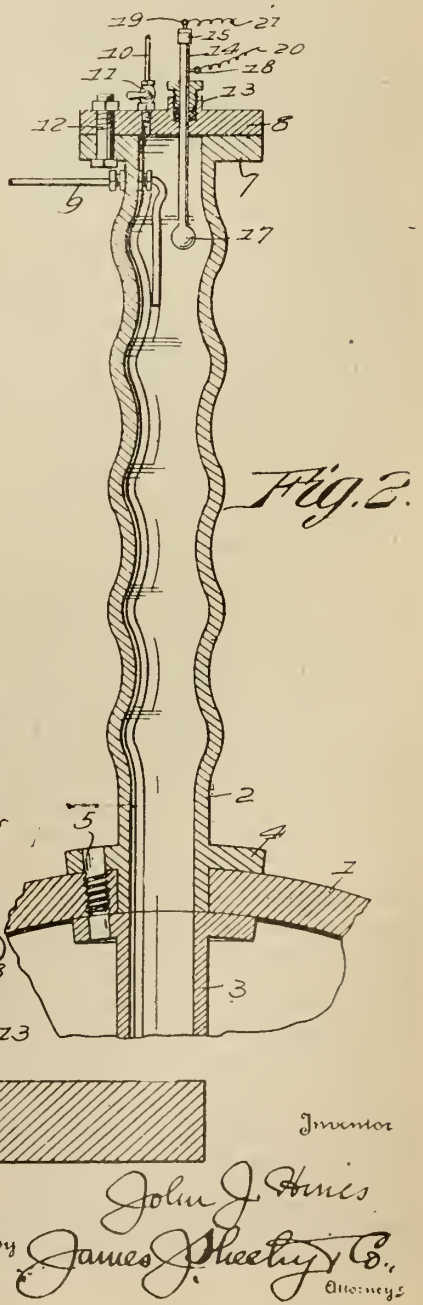


Fig. 2.

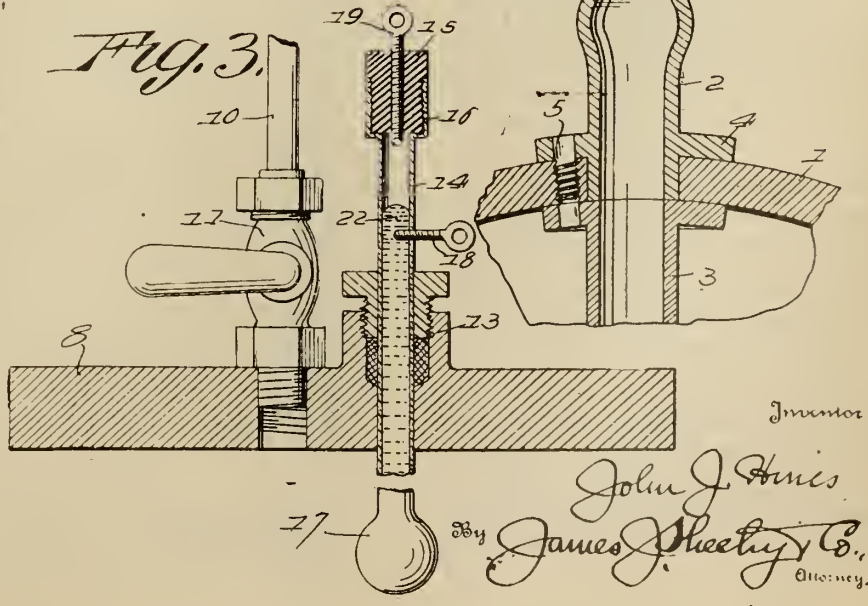


Fig. 3.

Inventor
John J. Hines
By James J. Keeley & Co.
Attorneys

Inasmuch as my invention does not reside in the alarm or alarms, I would have it understood that without involving departure from the scope of my claimed invention, any signal may be employed to apprise those in authority that the water in the boiler is dangerously low.

When desired a cock 11 may also be employed on the plate 8, the said cock being connected to a small bore pipe 10. This pipe 10 may be carried downwardly and equipped with a second cock (not shown) within convenient reach of the operator so that incidental to the operation of getting up steam in the boiler, air may be exhausted from the pipe 3 and the column 2. It will also be noted that when the last mentioned cock is opened, during the operation of the boiler, the column 2 will be filled with water of the same temperature as that in the boiler and the electrical circuit will be completed to sound the alarm and enable the engineer to make certain that the apparatus is in good working order.

Also when desired, a small copper pipe 9, Figure 2, may be let from the feed pump side of check valve into the column 2, adjacent to the mercury container 14—17. By virtue of this provision, feed water may be passed through the column 2 so that the temperature in the column will be the same as that of the feed water, and this condition will continue until the water level drops when by reason of the column being occupied by high temperature steam the circuit will be closed and the alarm sounded. It will be manifest that the feed water will pass through the said steam but will not appreciably diminish the temperature thereof.

Having described my invention, what I claim and desire to secure by Letters-Patent, is:

1. The combination of a boiler, a flanged depending conduit carried by the upper portion of the boiler within said boiler, an exterior hollow convoluted column provided with a flange portion at its top and a flange portion near its bottom and in alignment with said conduit, a closure plate secured to the flanged upper portion of the said column, a mercury container carried by said plate and depending within the column, a terminal secured to the container intermediate its length and normally in contact with the mercury therein, a second terminal carried by the upper end of the container and insulator therefrom normally resting out of contact with the mercury, and means for simultaneously securing both of the flanged portions of the conduit, and the column to the upper shell of the boiler in vertical alignment.

2. The combination of a boiler, a depending conduit secured to the upper portion of the boiler within said boiler, an exterior convoluted column secured to the upper portion of the boiler provided with a flanged upper end to which is fixed securely a closure plate, a mercury container carried by said plate and depending within the column, a terminal secured to the container intermediate its length normally in contact with the mercury therein, a secured terminal carried by the upper end of the container and insulated therefrom normally resting out of contact with the mercury, and a valved air pipe carried by the closure plate and depending within the interior of said column and leading to the atmosphere.

3. The combination of a boiler, a depending conduit secured to the upper portion of the boiler within said boiler, an exterior hollow convoluted column communicating in vertical alignment with and forming a continuation of said conduit and an increased radiating surface, a thermal circuit closing means positioned at the top portion of the column within the same, and a valved air pipe secured at the top of the column depending therein and leading to the atmosphere.

4. The combination of a boiler, a depending conduit secured to the upper portion of the boiler within the same, an exterior hollow column communicating with and forming a continuation of said column in vertical alignment therewith, a closure plate secured to the flanged upper portion of said column, a thermal circuit closing means carried by said plate at the upper portion of the column and depending therein and leading to the atmosphere, and a feed water pipe fitted into the top portion of the column and suspended therein adapted to maintain a uniform temperature within the column until the water in the boiler reaches the danger level.

5. The combination of a boiler, a depending conduit secured to the upper portion of the boiler within the same, an exterior hollow column secured to the boiler in vertical alignment with and forming a continuation of said conduit and increased capacity of radiating heat into the atmosphere; said column being formed of conductive material, valved means secured to the top of the column and in communication with its interior and the atmosphere, whereby air may be exhausted from both conduit and column thermal circuit closing means secured to the top of the column and depending therein, and a feed water pipe led into the top portion of the column adapted to prevent the temperature from rising within the column sufficient to cause an alarm before the water in the boiler reaches the danger level.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JOHN J. HINES.

Witnesses:
Fred E. Lordly,
W. H. Wilson.

NEW BRITISH ENGINEERING PROJECTS

In spite of economic difficulties whic are world-wide, serious attention is be ing given in Great Britain to many im portant engineering schemes. One o those is the construction of a ship can between the Forth and the Clyde. Statis tics have been placed before the Goverr ment with the object of proving that th construction of such a canal would at tract a profitable volume of traffic. An other important scheme is the construc tion of a railway tunnel beneath th Thames at Gravesend with connection to the railway systems north and sout of the river. The estimated cost of thi tunnel is £6,000,000 (six million pounds Steps are also being taken to re-organ ize the canal system of London, and im portant proposals were recently brough forward by a Government Committee.

STATIONARY ENGINEER AN ALDERMAN

It is somewhat unusual to find a station ary engineer who is also a member of th city council, but this is the case of Ale W. M. Stewart, of Sault Ste. Marie. Mr Stewart, who has had a wide experienc as a steam engineer, recently passed hi examination for the Ontario First Clas license, and is Chief Steam Engineer for th Algoma Steel Co. Like so many of th successful steam engineers on shore, Mr Stewart served his apprenticeship to mar ine engineering in the old country, and fo some years sailed in the U.K. and Canadia trade as an engineer, obtaining the Board o Trade certificate in due course. Mr Stewart also served in the Imperial Navy during the war, from 1914 to 1919, rising from fourth class engine room artificer t first class E.R.A. during his service.

Mr. Stewart also devotes his leisure time to instructing those under him, and during the winter months conducts a class in steam engineering, having the satisfaction o seeing many of his pupils gain their certificates in various degrees. That the men appreciate this service, may be gathered from the fact that his students last year presented him with a valuable gold watch suitably inscribed.

The Taylor Instrument Companies Rochester N.Y. and Church Street, Toronto, illustrate a number of their recording and indicating instruments in their catalogue No 1. A special feature of their recording thermometers is the dustproof and fume proof pressed metal cover, for situations where dust is met with in large quantities.

The Sarco Co. Inc., New York City have developed an indicating thermometer under Fournier patents, which is illustrated in a circular issued by the company. The thermometer is designed for both industrial and scientific uses, and can be furnished over a very large range of temperatures. The thermometer can be placed at any distance from the bulb, and the connecting tubing will not have any effect on the reading of the dial.

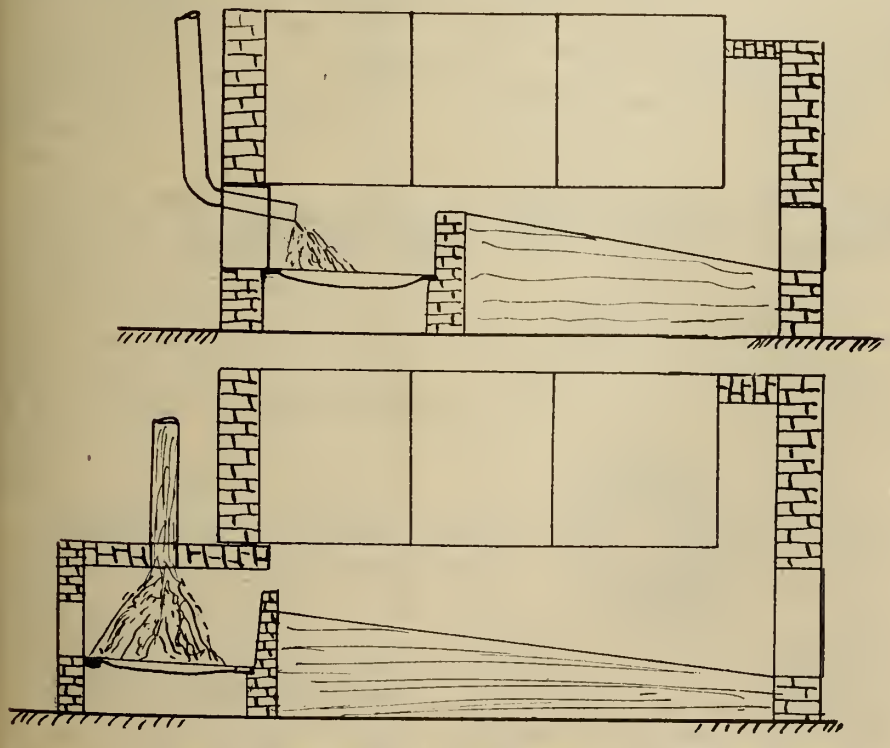
OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

FIRING WITH WOOD REFUSE

Question:—We have some boilers fed direct with wood shavings, and in my opinion the settings are unsuitable for this kind of fuel. I would like to have some one's opinion who has had experience with this problem. The trouble I find is that there is excessive heat in back of the boiler, coupled with high flue temperature, causing a loss of valuable heat. The enclosed sketch gives an outline of the present setting.

Answer:—The ordinary setting such as shown in our correspondent's sketch is not suitable for burning fuel consisting entirely of wood shaving or refuse. The method usually adopted is to build a Dutch oven or extension furnace, such as shown in the sketch below. The shavings are fed in on top of the extension furnace, where they form a pyramid on the grates, and leave plenty of room for air to pass through the grates in front of and behind the pile of shavings. When shavings are distributed evenly over fire grates it is very hard to get the necessary air through them to complete combustion. In the extension furnace, ignition takes place some distance in front of the boiler, and the flame impinges on the brickwork of the arch which acts as an ignition arch. The flames are thus not cooled by the boiler shell immediately on ignition, and there is plenty of room in the passage behind the extension furnace for the gases to be completely burned while passing through the combustion chamber and tubes of the boiler. In the ordinary setting the gases do not have time to be completely burned, and thus leave the tubes with a large amount of heat still available. The setting which is shown in outline, can be seen in any sawmill where shavings are used, which is the case in the majority of these mills. A door is placed in the front wall just as in the ordinary setting, and this is used for lighting up purposes and for cleaning. The extension furnace is usually about six feet long and the boiler should be set about four or five feet higher than the grates. The top arch may be of the suspended pattern or the ordinary brick arch, and the extension furnace brickwork should be well stayed with buckstays. The hopper through which the shaving pipe feeds should be cast iron set in the top arch.

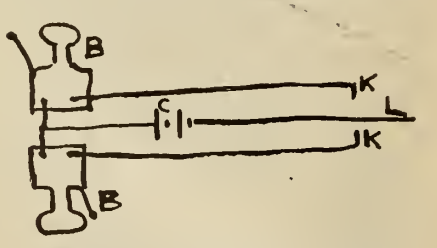


Top View Shows Setting at Present—Lower View, Dutch Oven Setting.

ANOTHER HEATING KINK

By C. Pye

Some trouble having been experienced in heating a building some distance from the boiler room, a simple device was adopted to remedy it. The building in question had to be kept at a temperature not exceeding 70 degrees, and not falling below 66 degrees. This meant a margin of only four degrees, and any encroaching on the



Arrangement of Temperature Alarm Bells

margin either way caused considerable trouble for the engineer.

Referring to the sketch, B. and B. are ordinary electric bells. V is a dry battery. One lead from the battery is taken to the two bells, while the other battery lead is connected to a copper wire L stretched over two insulators about 18 feet apart, with a sag of about two inches in the centre. The leads from the other terminals of the bells are taken to two copper nails, placed one above and one below the wire L, about one quarter of an inch apart. The bells are in the boiler room, while the wire L and the terminals of the two wires from the bell binding posts are in the room to be heated. The operation is simply that when the room cools the wire L contracts and makes connection with the top wire, ringing the top bell, and when the room gets too hot the opposite effect is caused. This little trouble saver has been in operation for some time and has given great satisfaction.

LONG LIVED BRITISH ENGINES

Many examples have come to light of British engines which have been at work from the very earliest days of steam engineering, The Science Museum in London has recently placed among its exhibits a pumping engine made in the year 1791 by Newcomon. This engine was at work until the year 1915 at a colliery near Derby. Another engine which was made in the early part of the 19th century has also been presented to the Museum. Both engines are still capable of doing useful work although they represent pioneer types very different from the British steam engines of today.

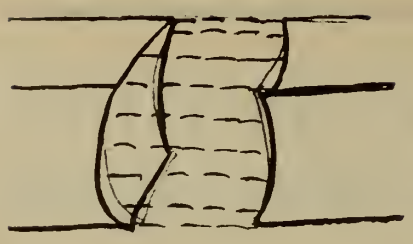
A GENERATOR TROUBLE

There sometimes occur in the course of an engineer's duties, peculiar happenings which can't be seemingly accounted for at the moment, and which may cause him considerable anxiety through not being able to cope with them. Sometimes when such is the case an expert is called in to determine what is wrong, and to advise us what to do to put it right. These gentlemen arrive, try to look intelligent and mysterious, smoke black cigars, and we presume, collect a fee, and depart, and that is all there is to it. The trouble remains, and we have to "go to it" ourselves. Such was the writer's experience and it is herewith presented as it may perhaps prove a help to some brother engineer who may have had a similar experience.

It was decided to install a new 4000 K.W. Unit in a plant which consisted of 2 1500 3000 R.P.M. 50 cycles. The new unit arrived and was duly installed. We were told by the erectors that a specially built exciter was being installed with it, and when the writer enquired, why it was special, no particular explanation was forthcoming.

Then the trouble began. Between the shaft and the frame of the machine heavy eddy currents were observed and measured. It was also noted that the designers of the set must have anticipated such a happening because they had gone to great pains to have the bearings at the exciter end carefully insulated with fibre shims, pillow block bolts with fibre washers and ferrules etc. Even the water and oil services to the bearings had fibre distance pieces fitted at the entering glands with the object, we presume, of combating the aforesaid eddy currents. The erectors sent several men at different times to try their luck at it, but all to no purpose. On this particular machine, the slip rings were placed between the exciter and the stator end bearing, and a thin perforated sheet metal cover was placed over them, and carefully insulated with felt. There were stiffening bars put between the exciter and the end bearing to carry this perforated cover. These were cut in half and joined together again with a vulcanite plate to ensure that no metallic path was between the end bearing and the exciter. After all these precautions had been taken, the eddy currents were still in evidence. It was found that there still was a path through the lock-nuts on the perforated cover. This cover was taken off and the machine was run without it with no further trouble. Of course this could not stop the eddy currents. The cause of these currents, in the writer's opinion, which may or may not be correct, is as follows.

Appended is a rough sketch of an Elementary Alternator developing 1 Volt at frequencies of 60 to 25 showing the effect of reducing the frequency. Since for the same number of poles the R.P.M. have to be decreased to decrease the frequency, increased flux is required to develop the same voltage. Hence in construction low frequency machines require larger magnets, increased number of turns in series on the armature coils and larger exciter units as compared with machines built for higher frequency. Vide Hawkins)



Frequency 60 Requires 3,600 R.P.M. per Volt, giving 37.777 L. of F.
Frequency 25 Requires Per Volt 1,500 R. P. M. 66.666 L. of F.

Taking the above ratios it follows that
3600: 3000: 27.777: x.
x—23147 L of force developed at a periodicity of 50 per second.

Therefore we must either increase the number of turns on the inductor field, or else supply a much larger current through that field. This had been done by installing a specially built exciter to supply the above heavy field current, and the nearer this field is excited towards the saturation point the more likelihood there is of strong eddy currents. This then was the cause of the trouble. The new 4000 K.W. Unit was a machine designed for running at 3600 R.P.M. 60 cyles per sec, changed to 3000 R.P.M. 50 cycles per sec by alteration of the governor gear. From an economical standpoint the 4000 K.W. Unit at 1000 K.W. requires at the exciter 167 Amps at 73 Volts about 16 H.P. while one of the small 1500 K.W. sets require for the same load (1000 K.W.) 62 Amps at 62 Volts or little more than 5 H.P.

PULVERIZED COAL

Continued from page 34

a screen 200 meshes to the inch, and about 95 per cent. through a screen of 100 meshes to the inch.

After pulverizing, the coal is conveyed to a bin, from which it is usually fed to the furnace by means of a screw conveyor in conjunction with an air blast. Both the coal feed and the air supply must be under positive control, in order to insure satisfactory results. The construction of the furnace must be such that the lining, after becoming heated will remain hot continuously, and the combustion chamber must be much larger than is necessary when an ordinary grate fire is used.

A more detailed description of the various methods employed for pulverizing and burning coal would doubtless be interesting, but enough has been said, already, to serve our present purpose, which is to call attention to the fire-hazard associated with the preparation and use of pulverized coal.

Coal dust is only one of a large number of substances which will explode when suspended in air in certain proportions, and ignited; and even when some element is lacking in the conditions that are essential to the production of a true explosion, the dust cloud may become ignited so as to give rise to a great sheet of flame, which in an inconceivably short time spreads throughout the room or other space in which the dust is suspended, and usually brings death to any person who may be in its path. A case of the latter kind, which occurred in a cement mill, is described in C. F. Herington's book, "Powdered Coal as a Fuel", as follows: "A foreman and some of his men were repairing and cleaning a mill. One of the men had rammed a piece of waste on the end of a stick into a part he was cleaning, and somehow (no one knows how) it caught fire as he pulled out. Immediately there was a hissing sound like a pinwheel going off, or like escaping steam, and in a flash this traveled the length of the room, down a stairway, and back several times, in layers just like a train of powder; only there was no report, no explosion,—just a hissing (accompanied, of course, by flame). The men who came out were absolutely nude, yet they seemed to retain their faculties. The foreman said, 'I'm done for and am going to die.' He was able to tell what had happened, before he became unconscious. They all died shortly afterward."

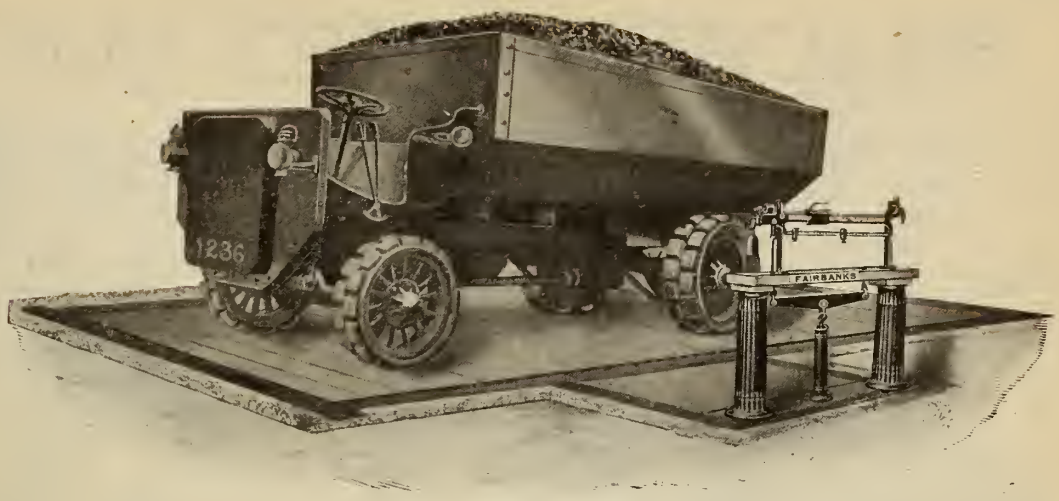
Recent disastrous dust explosions in grain elevators, which have caused large loss of life and enormous property damage, are doubtless still fresh in the minds of our readers. Coal dust is capable of producing similar results when it is fine enough and present in a sufficient quantity, and it should, therefore, be handled and controlled with great care. Grinding and pulverizing mills, unless properly inclosed, emit dust which settles on pipes, on overhead beams and similar structural members, and on all other objects in the vicinity. If these accumulations are dislodged, and the dust cloud so produced is then brought in contact with a flame or spark, an explosion of fire is almost inevitable. The source of ignition may be an open-flame light of some kind, or a spark produced by some metal object which has found its way into the pulverizing mill, or an electrical spark resulting from improperly grounded machinery, or an electric arc due to defective insulation of wires, or the arcing of a motor, switch, or other electrical apparatus, or the fire in a furnace or forge.

Experiments made by United States Bureau of Mines have proved that coal dust is not necessarily explosion-proof, even when largely diluted with other dust of an incombustible character. It was found for example, that a mixture containing 30 per cent. of powdered coal dust and 70 per cent. of finely powdered shale could be exploded. The fact that there may be a considerable inert dust in an industrial plant, in addition to coal dust, therefore does not eliminate the possibility of an explosion.

We have no desire to condemn the use of pulverized coal, nor to terrorize those who wish to adopt it; but we certainly do wish to emphasize the fact that fine coal dust is a source of serious hazard unless it is handled carefully and intelligently. Following are some of the precautions that should be observed in order to insure a reasonable measure of safety in the use of it.

(Continued on Page 48.)

Check Your Weights on Fairbanks Scales



The ever increasing use of motor trucks has created a demand for scales to stand more severe service than the ordinary wagon scale because most trucks carry approximately 85 per cent of the load on the rear axle.

Fairbanks Scales for heavy motor truck weighing, are designed to sustain 50 per cent of the capacity rating on each of the four bearings or 100 per cent on each end.

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Size.	Seamless	Lapweld.
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1¼-in.	27 25	.....
1½-in.	26 25	27 00
1¾-in.	29 75	24 00
2 -in.	29 25	22 00
2½-in.	44 75	28 00
3 -in.	49 25	34 00
3¼-in.	.....	42 50
3½-in.	63 50	37 50
4 -in.	85 00	48 50

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Plates, 3/16-in.	$4 25	$3 90
Plates, ¼-in. up	3 75	3 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.09	20.13	19.90	24.04
1½	19.19	24.06	23.79	27.84
2	25.72	20.13	19.90	24.04
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

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4½-in. and larger, 40%.

4-in. and under, running thread, 20%.

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4½-in. and larger, 20%.

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Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

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	Per Cent.
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Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
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Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
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Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

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Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43
Emery cloth	list, plus 37½
Sal soda	0 03
Sulphur, rolls	0 05
Sulphur, commercial	0 04
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toront
Bars, ½ to 2-in.	$31 00	$34
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42
Copper sheet, planished, 16-oz. base	42 00	48
Braziers', in sheets, 6 x 4 base	35 00	41
Copper tubing, seamless	0 43	0

RUBBER BELTING

Standard	10
Best grades	15

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13
X L C R	14½		

Colored

Lion	13½	Popular	10
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrow	30	Anvil	22
Axle		Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$39 00	$40 0
Spelter	7 75	7 5
Lead	5 75	7 5
Antimony	8 00	8 2
Aluminum	34 50	30 0

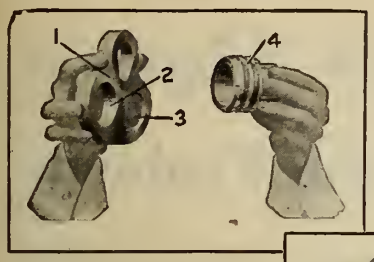
Prices per 100 lbs.

LEAD SHEETS

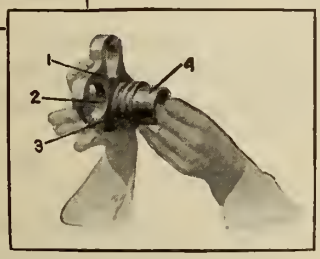
	Mont.	Toront
Sheets, 3 lbs. sq. ft.	$10 50	$14 5
Sheets, 3½ lbs. sq. ft.	10 25	14 0
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 5

Cut sheets, ½c lb. extra.

Cut sheets to size, 1c lb. extra.



1. Rotating Disc
2. Port
3. Seat
4. SEALING BUSHING

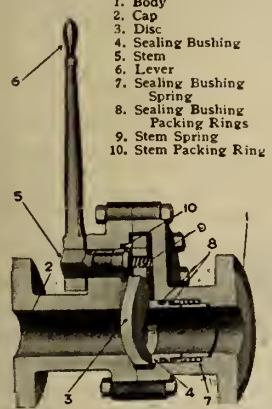


Sealing bushing on inlet side makes it *double tightening*

The Yarway Double-Tightening Blow-Off Valve is of lever-operated, swing-gate type, with unique feature of sealing bushing on inlet side, making it double-tightening on both sides of gate.

The two illustrations above show clearly how sealing bushing establishes contact with rotating disc or gate when valve is closed. Guard on tailpiece of sealing bushing protects spring and prevents scale-forming matter getting behind bushing and interfering with spring action.

When no pressure is on valve, bronze spring holds bushing against gate. When line pressure is applied, bushing is forced up tight against machined surface of gate and is continually "ground in," resulting in an absolutely tight valve.



1. Body
2. Cap
3. Disc
4. Sealing Bushing
5. Stem
6. Lever
7. Sealing Bushing Spring
8. Sealing Bushing Packing Rings
9. Stem Spring
10. Stem Packing Ring

Yarway Double-Tightening Valves are especially fitted for use in tandem arrangement with the Yarway Seatless Blow-Off Valve, and this type of installation has proved highly successful.

Bulletin B-410 contains full descriptions of both valves, with dimensions and price lists. We have a copy awaiting your request.

·YARNALL·WARING·COMPANY·
7604-20 Queen Street
Chestnut Hill··Philadelphia
Representatives in all Principal Cities
For Complete List of Offices see Sweet's Engineering Catalog-Keystone Mining Catalog or Chemical Catalog

YARWAY SEATLESS BLOW-OFF VALVE · YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE · YARWAY BOILER SKIMMER · YARWAY ADJUSTABLE SPRAY HEAD · YARWAY HYDRAULIC VALVE · YARWAY UNLOADER · YARWAY LEA V-NOTCH METER · YARWAY PIPE CLAMPS · ETC.
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The steadily increasing demand for our products in Canada has brought us to the point where we are now arranging to carry a stock of standard instruments, etc., at our Toronto office. Here we can give our Canadian customers the service they are entitled to as well as full information regarding Prices, Technical Data, Deliveries, etc.

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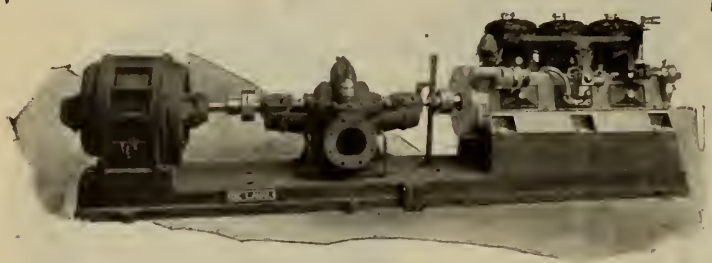

One of 2 Six Cylinder 120 H.P. Sterling engines installed at Champaign-Urbana Water Company, Champaign, Ill., by DeLaval Steam Turbine Company, of Chicago for reserve. Engine arranged for speed of 1,160 R.P.M.

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PULVERIZED COAL

(Continued from page 44)

First of all, it is highly important to prevent accumulations of coal dust particularly in the room where the pulverizing apparatus is situated. Powerful artificial ventilation is helpful for this purpose, but no great reliance should be placed upon it, especially in the angles and corners of a building, and in other places situated outside of the direct path of the air currents. The use of well-designed vacuum-cleaning apparatus is recommended, and the dust collected by means of such apparatus may be delivered to the pulverized-coal bin and used in the furnace.

Explosions are likely to occur in driers of the direct-heat type, where the hot gases come in contact with powdered coal or where red-hot cinders may drop into the screw conveyor which feeds the coal to the pulverizer. There are other types of driers available, designed and constructed so that this hazard is eliminated; and we recommend that preference be given to apparatus in which there is no possibility of direct ignition.

The coal should be delivered from the drier to the storage bin at a temperature not greatly exceeding 125° Fahr. Unless care is exercised in properly controlling the fire used for heating the drier, the temperature is likely to rise considerably above this point; and if the coal is delivered to the bin in a highly-heated state, and is left there even for a comparatively short time, it may take fire spontaneously while in storage. It is specially important, therefore, to have the drier operated by a competer and thoroughly skilled man. The fire that effects the drying should be drawn or effectively checked whenever it becomes necessary to stop the drier.

Back-fires from the combustion furnaces sometimes cause fires in the pipes through which the pulverized coal is distributed. These may occur if the air pressure in the distributing pipes drops below that in the furnace, on account of stopping the fan, or in consequence of an obstruction in the pipe line, or for any other reason. Every possible precaution should be taken to prevent such back-fires.

Fires which are probably due to spontaneous ignition are sometimes discovered in storage bins used for pulverized coal. As already indicated, these may be due, primarily, to the delivery of over-heated coal from the drier. The bins should be kept as cool as practicable, and this means that they should be located at a safe distance from furnaces, steam pipes, and other sources of heat. If there is reason to believe that stored pulverized coal is heating, a rough-and-ready idea of its approximate temperature may be had by thrusting an iron rod into the mass and leaving it there until it has attained the same temperature as the coal. When the rod is withdrawn, it will be easy to tell, from its temperature, whether the coal is dangerously hot or not.

In concluding this article, which is in no sense a complete exposition of the subject, we may say that the fire and explosion hazards of pulverized coal are comparable, roughly, with those of fuel-oil and gas. This fact is probably not realized as generally as it should be, and correspondingly less caution is observed in handling coal dust.

—Traveller's Standard

"Of all the auxiliary turbines in the plant the Sturtevant Turbines have been the most satisfactory....."

Two Sturtevant turbines driving boiler feed pumps were installed in a large power house in 1914. The units consist of Type "E" Turbines and 1,500 G.P.M. Centrifugal Pumps.

During this time one has run continuously and the other one used twice a day during peak loads. No repairs have been furnished for them for at least four years. In this same plant there are altogether 15 small turbines driving auxiliary apparatus of reputable make and the fact that the 2 Sturtevant Turbines were singled out for such praise is surely worthy of consideration. We direct connect

Sturtevant TRADE MARK **Turbines**

with any make of centrifugal pump and will erect both apparatus upon a suitable sub-base of cast iron. However, if the purchaser desires, we will ship the turbine direct with a flexible coupling between turbine and pump ready to erect upon his own foundation.

Our engineers will be glad to consult with you before selecting your turbines. Sturtevant Steam Turbines are used to drive exciters, boiler feed pumps, house pumps, fire pumps, fans, blowers and special equipment and for whatever purpose you need auxiliary drives, they will advise you which is most adaptable and profitable.

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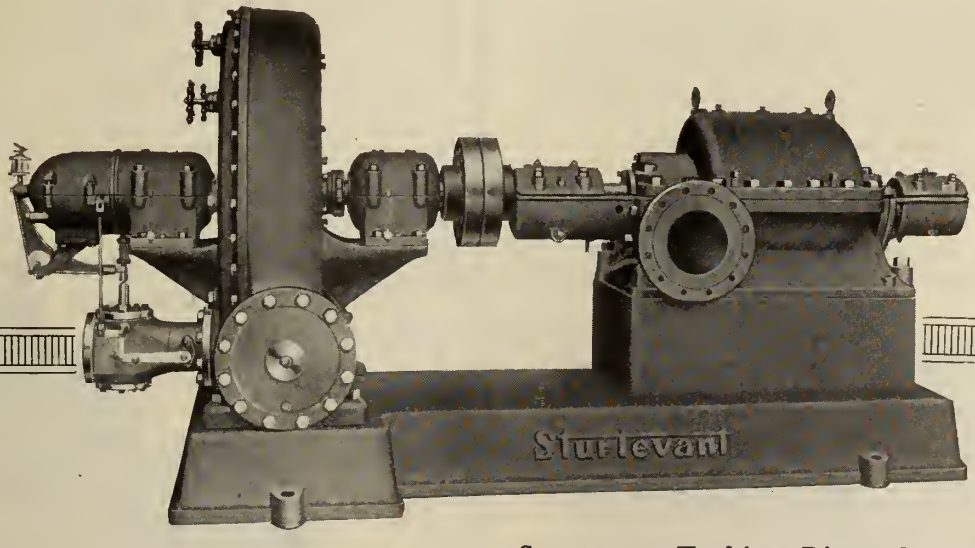

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COPPUS ENGINEERING & EQUIPMENT CO.
Worcester, Mass., U.S.A.
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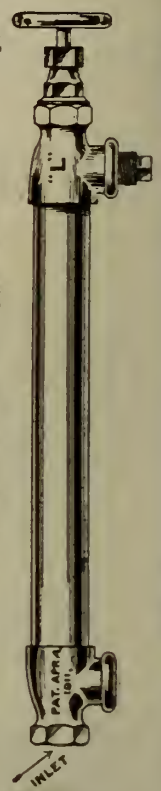

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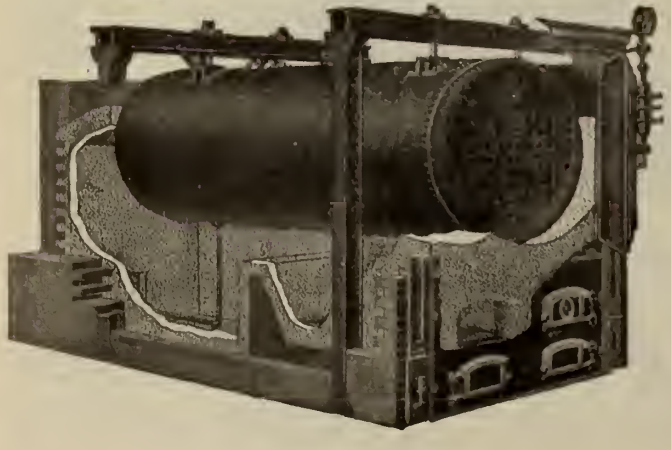

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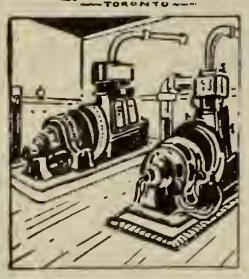

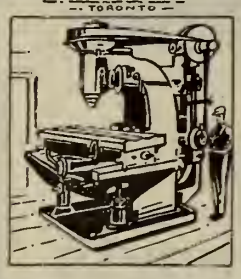

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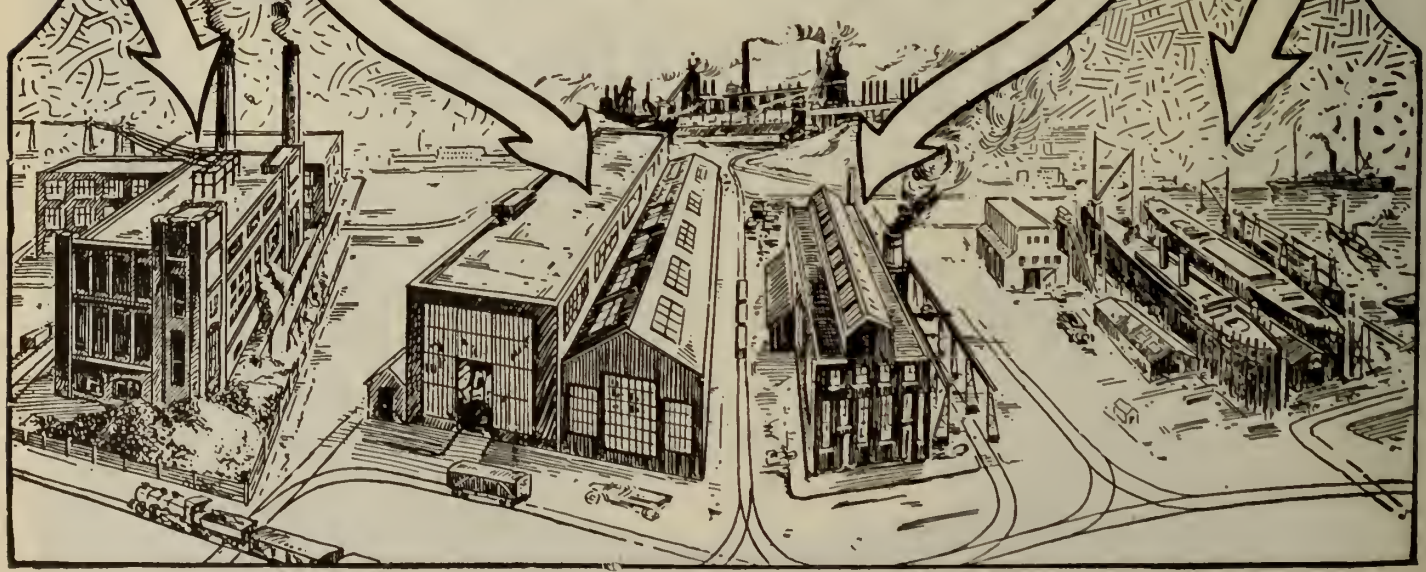

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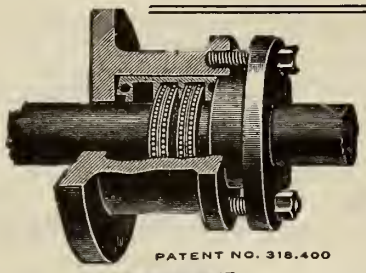

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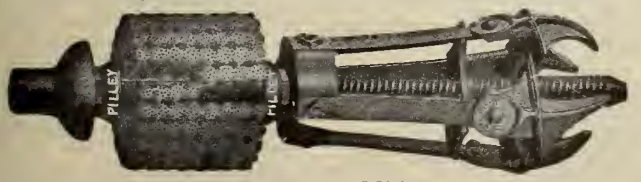

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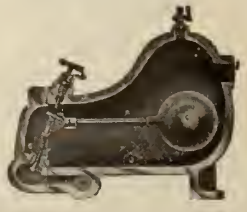

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Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ARCHES, BOILER AND COMBUSTION
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFINGS
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
W. J. Brown (Tucks), Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

ASBESTOS PACKED COCKS
Beldam Asbestos (Canada) Co., Toronto.
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BALATA BELTING
W. J. Brown (Tucks), Montreal.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal
Magnolia Metal Co., Montreal
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Co., Toronto.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS, BRASS
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd. Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co. Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited
R. C. Miller Oil & Supply Co., Ltd., Montreal

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc. Montreal Que.
Philip Gies Foundry, Kitchener, Ont.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILERS
Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

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Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
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W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

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Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio
Jas. Morrison Brass Mfg Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto

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Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

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BOILER SETTING CEMENT
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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

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Philip Gies Foundry, Kitchener, Ont.
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

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Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

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D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

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York Manufacturing Co., York, Pa.

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Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
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Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
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Can. Link-Belt Co., Toronto, Ont.

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Betson Plastic Fire Brick Co., Inc., Rome N. Y.
International Chemical Co., Toronto, Ont.
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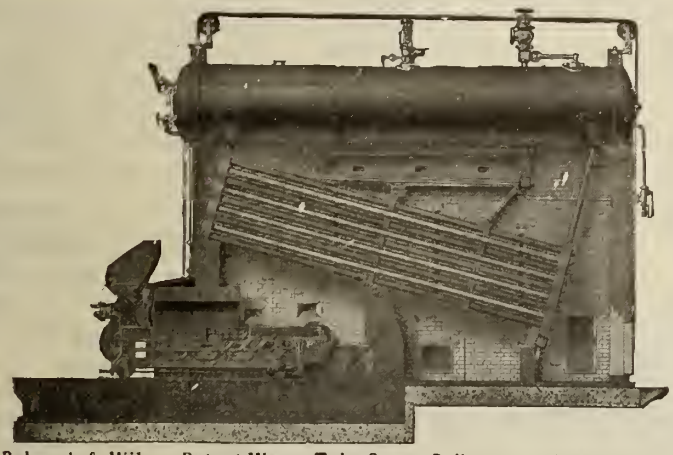

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ALSO

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HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
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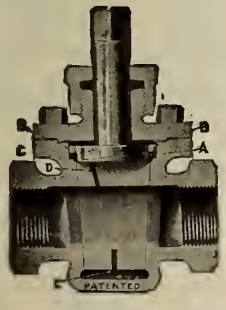

Convenient!

Contrary to the eight or ten turns with an ordinary globe or gate valve, the Homestead requires but **one** quarter turn!

Adaptable!

For air, steam, water, oil or acids. Made in Straightway, Threeway and Fourway patterns.

Leak-Proof!

Tightness is absolutely assured by a patented wedging cam that automatically forces the plug downward in closing.

Long Life!

Made of Brass, Semi-steel and special Acid-resisting Metal.

Write for Literature

Homestead Valve Mfg.Company

Pittsburg, Pa. Works: Homestead, Pa.

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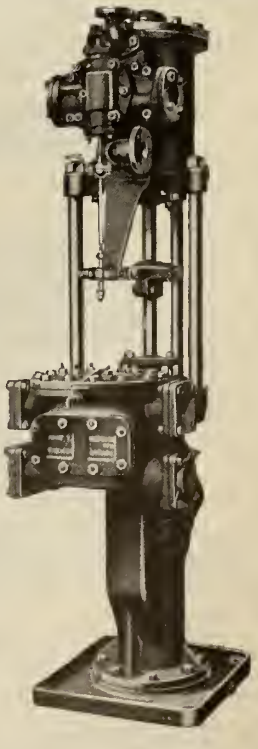

Our Special

THIS HEPBURN "SPECIAL" Outside Packed Ram Pump is more efficient than a piston pump and upkeep charges are less. Designed for high steam pressure and for water of high temperature. Only one packing gland to need attention and no bucket rings to change. The valve motion is extremely simple and positive in action. No loose parts —No adjustments necessary.

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Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
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Can. Mead-Morrison Co., Ltd., Montreal.
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MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati.
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
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Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
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CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
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Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

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Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

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DIAPHRAGM, PULP SCREEN
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York Manufacturing Co., York, Pa.

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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.
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Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

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Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
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Can. Johns-Manville Co., Ltd., Toronto.

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MacKinnon Steel Co., Sherbrooke.

ELEVATING MACHINERY
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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

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Leonard & Sons, Ltd., E., London, Ont.

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Leonard & Sons, Ltd., E., London, Ont.

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Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd. Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford
Robb Engineering Works Ltd. Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
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Darling Bros., Ltd., Montreal, Que.
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Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

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S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

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S. F. Bowser Co., Ltd., Toronto, Ont.
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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
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FIREPROOF COLD STORAGE DOORS AND WINDOWS
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Crane Limited, Montreal.

FITTINGS
Crane's Limited Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
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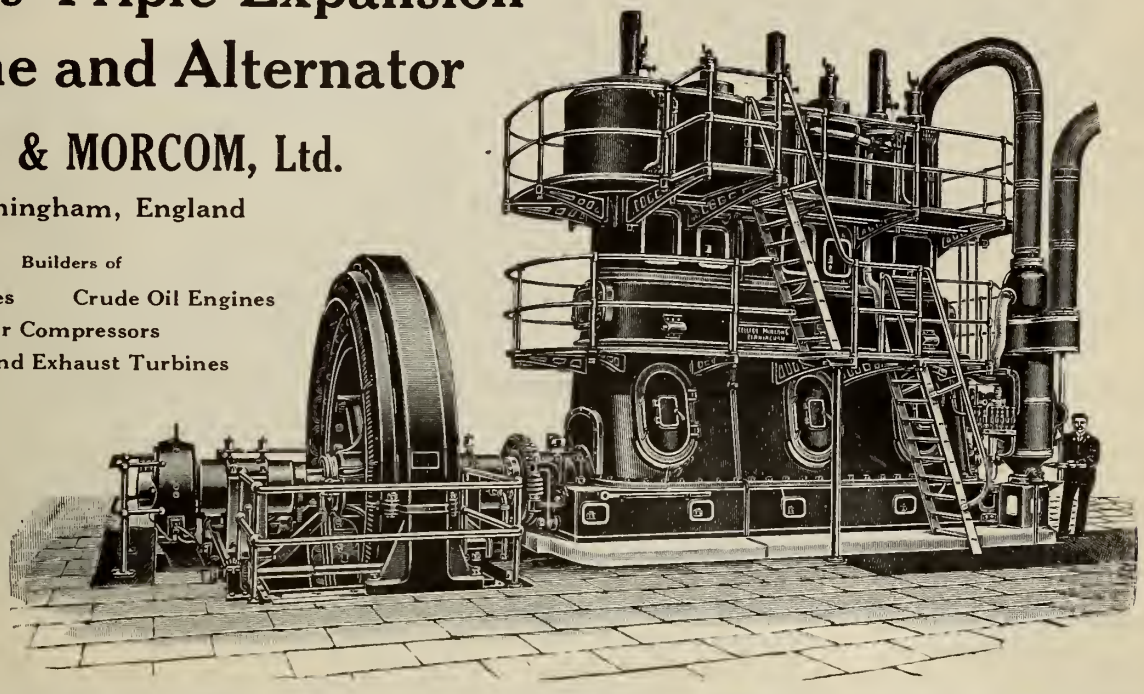

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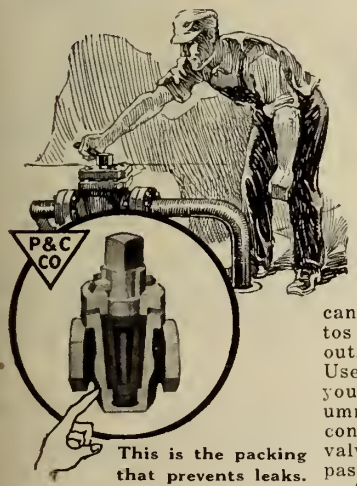
MONTREAL

For Boiler Blow-Offs



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Their unique design provides for the inequalities caused by expansion and contraction and keeps the valves tight under severe conditions.

The plug has no metallic bearing. Instead it seats tightly within a special vulcanized asbestos bushing. Asbestos packing is employed throughout.

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Pratt & Cady Valves cover a complete line for every class of service.

Our valve book sent free on request.

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Manufacturers of Valves and Asbestos Packed Cocks that give long and satisfactory service.

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Specify PRATT & CADY

VULCANIZED ASBESTOS PACKED COCKS

Williams' Superior Drop-Forged Wrenches

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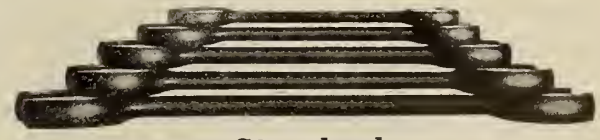

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THERE'S a Williams' Superior Drop-Forged Wrench for every purpose. Thick or thin, bent or straight, big or little —40 standard patterns in 1,000 sizes.

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Babcock & Wilcox, Ltd., Montreal
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Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

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FUEL OIL SYSTEMS
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Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

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Frick Co., Waynesboro, Franklin Co., Pa.
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Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.

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Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGES, WATER
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Jenkins Bros. Ltd., Montreal
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Penberthy Injector Co., Windsor, Ont.

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Arthur S. Leitch Co., Ltd., Toronto.

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MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

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Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford
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C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que.
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Leitch Co., Arthur S., Toronto, Ont.
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Philip Gies Foundry, Kitchener, Ont.
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Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

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Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GREASES
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Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Boston, Mass.
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J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
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Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
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Garlock Packing Co., Hamilton, Ont
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HOSE, SUCTION
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HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
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Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

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Pratt & Cady Co., Inc., Hartford, Conn

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Frick Co., Waynesboro, Franklin Co., Pa
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Can. H. W. Johns-Manville Co., Toronto

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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Yarnall-Waring Co., Philadelphia, Pa

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INSULATORS
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LAMPS, ARC
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Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
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OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
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Penberthy Injector Co., Windsor, Ont.
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OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

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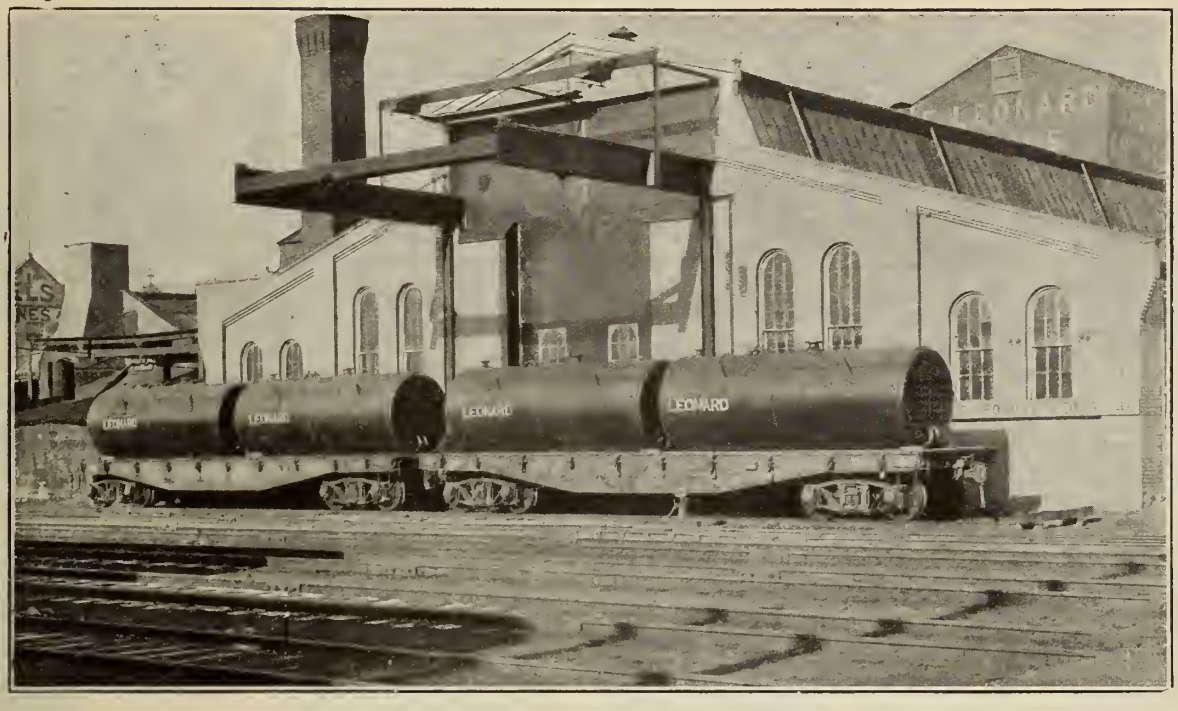
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton



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TO SAVE FUEL

⅛-inch Deposit on Tubes Increases Coal Consumption 30%
¼-inch Deposit on Tubes Increases Coal Consumption 66%
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MILLER'S BOILER CLEANING EXTRACT

Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

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Can. H. W. Johns-Manville Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

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MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

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The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

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Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
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PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ort.

PLATE WORK
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MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

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POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
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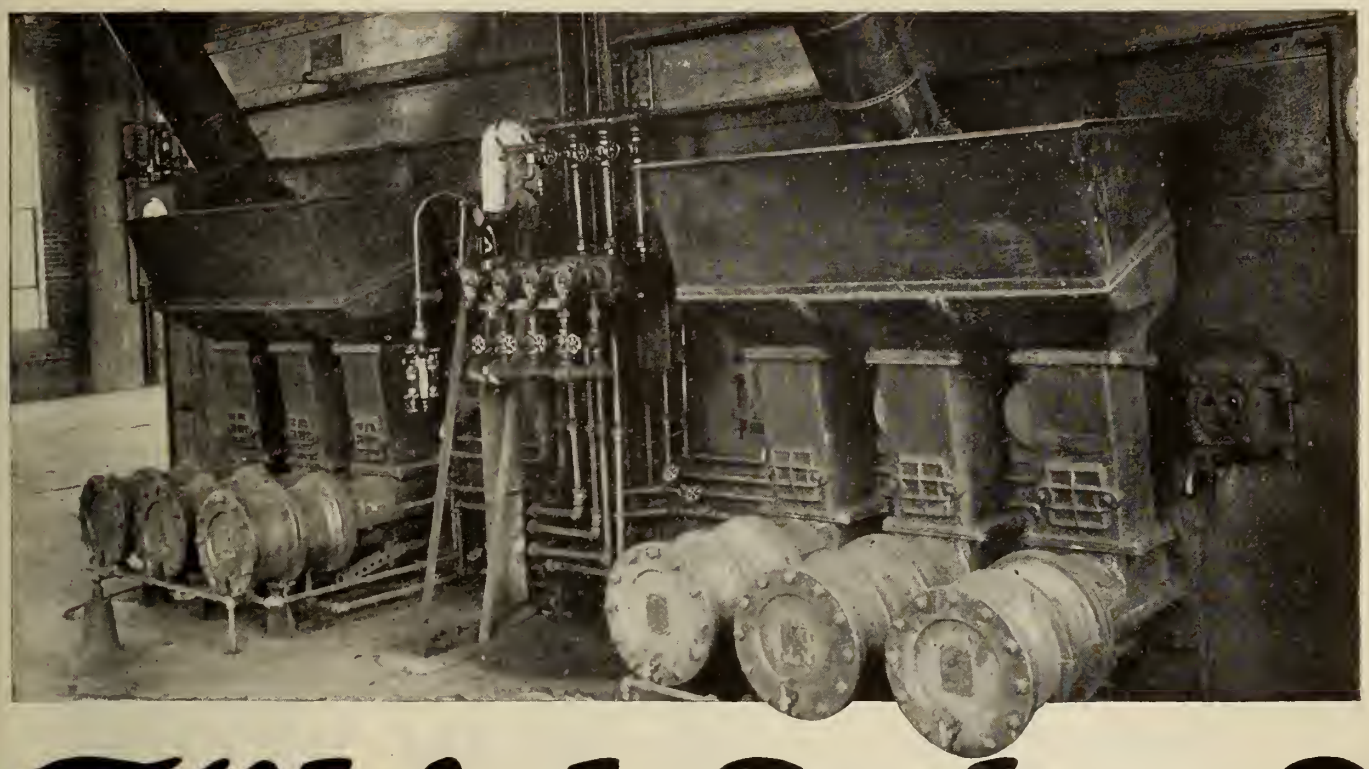

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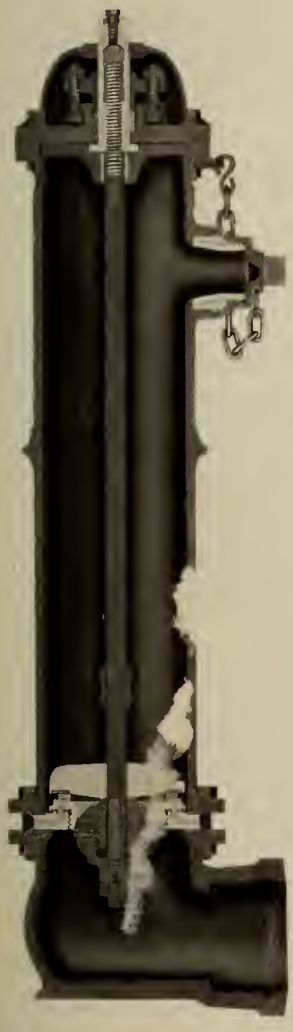

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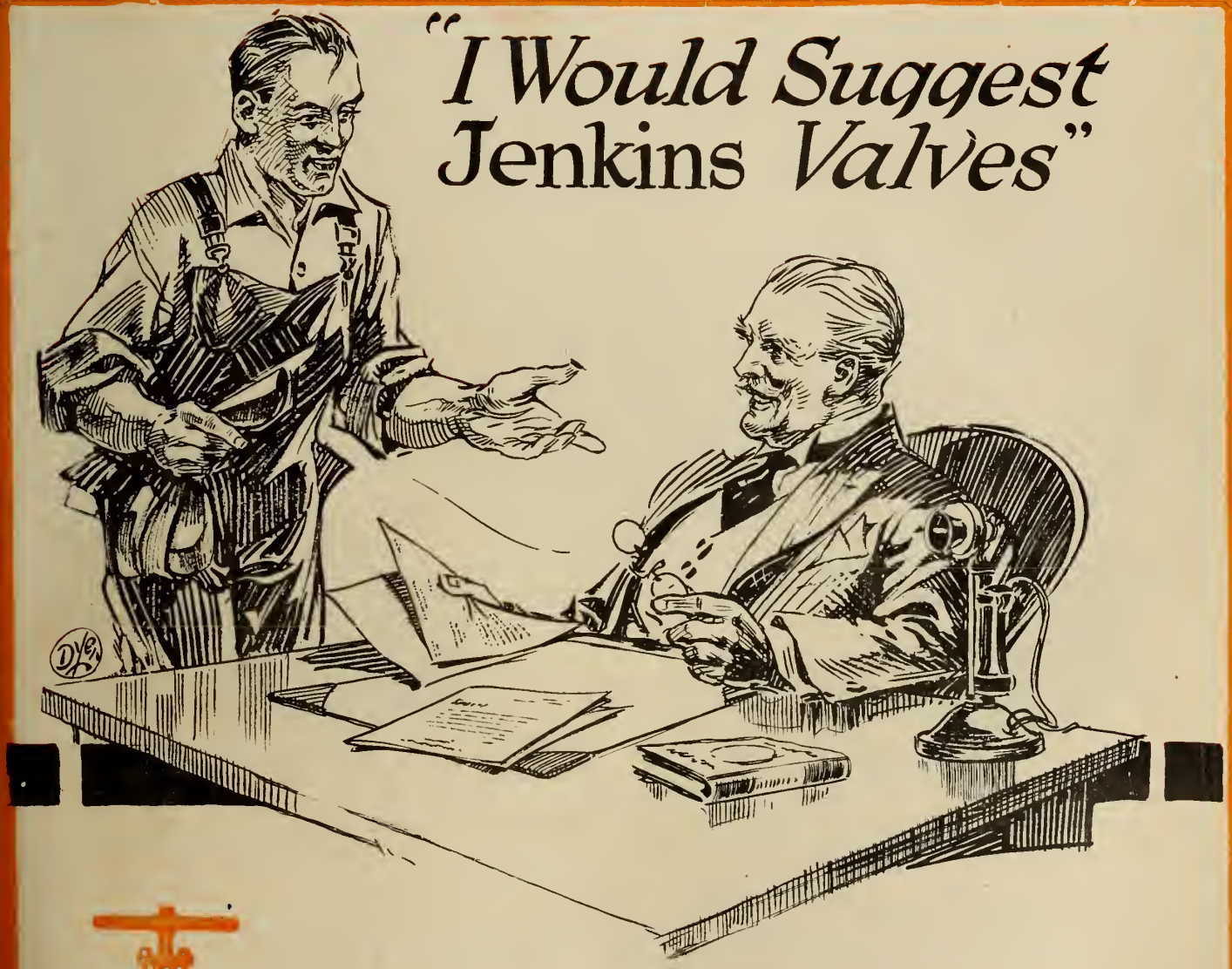

Fig. 402
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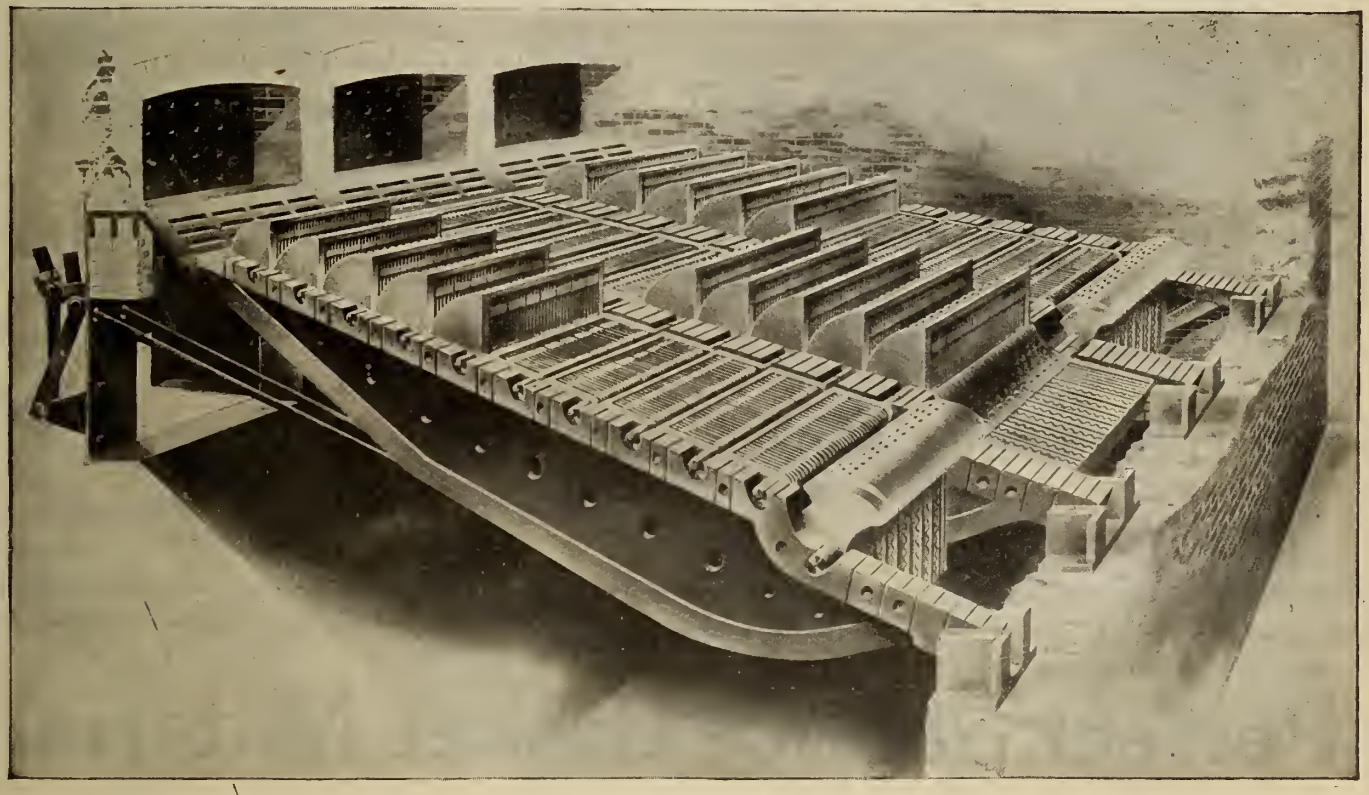

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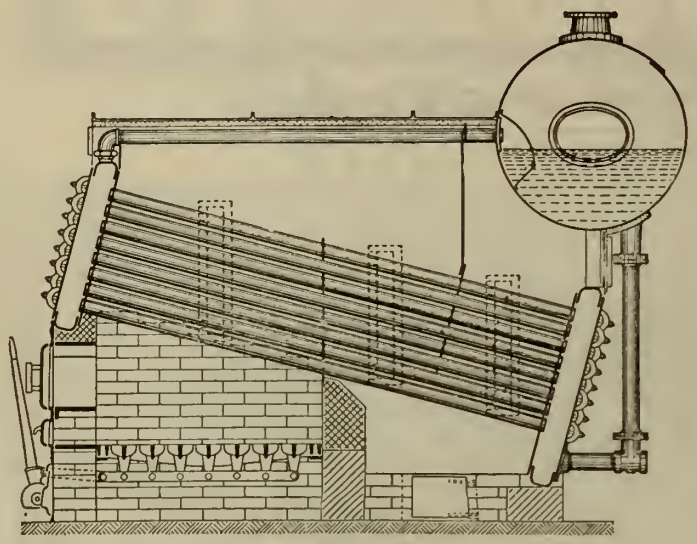

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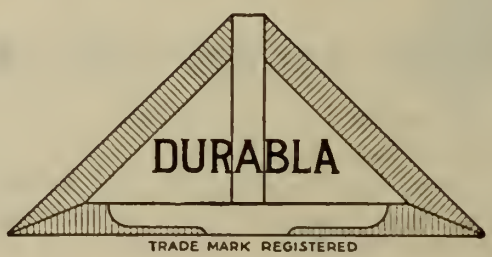

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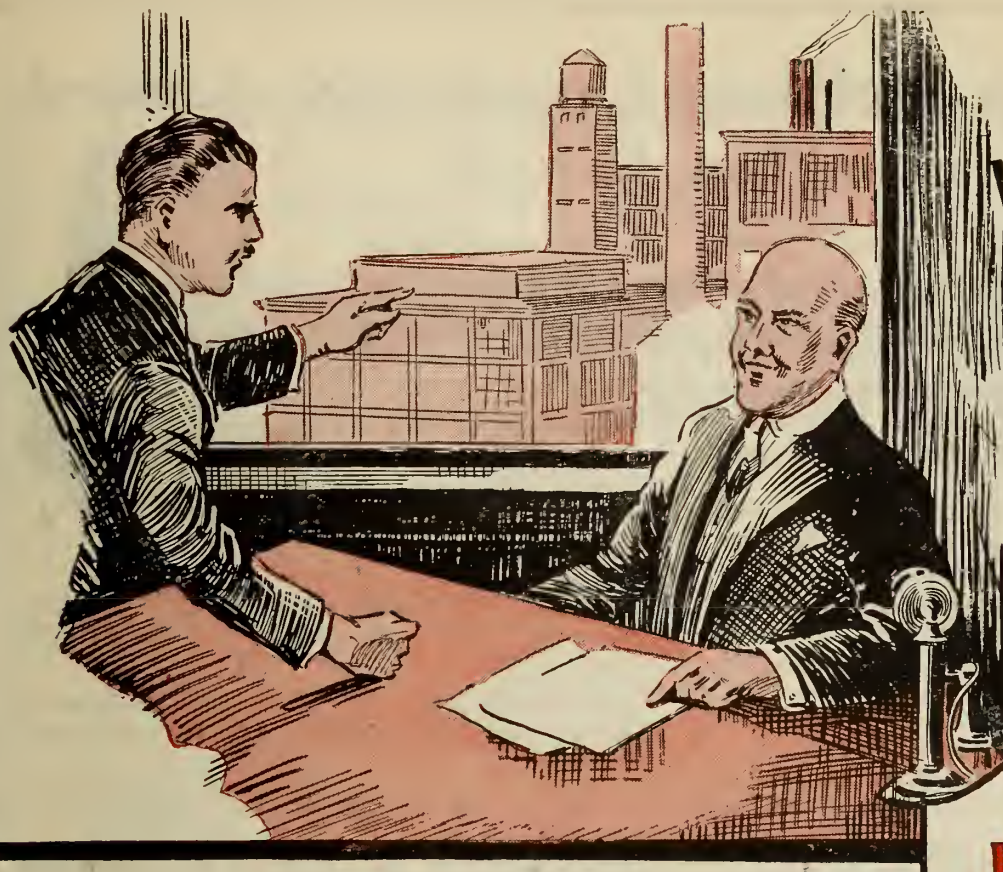

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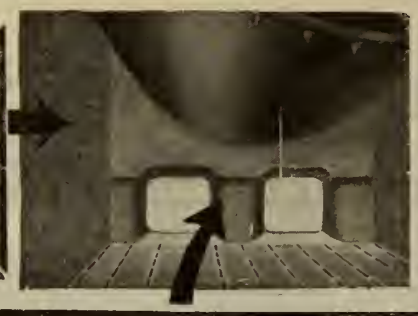

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75 H.P., 25 H.P., 20 H.P., 10 H.P., 8 H.P., 7½ H.P., 7 H.P. and 4 H.P.

Horizontal Engines
250 H.P., 40 H.P., 25 H.P., 15 H.P. and 5 H.P.

H. W. Petrie, Ltd.

Toronto and Hamilton

P&H WROUGHT PIPE BENDS
AND FLANGED PIPE JOINTS

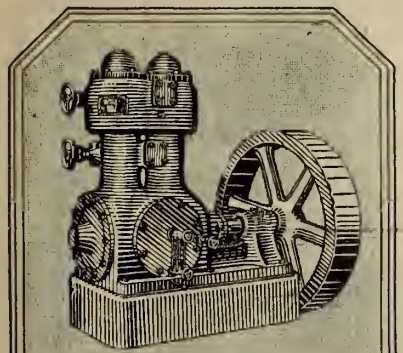
ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office: 100 CHURCH STREET, TORONTO, ONT.

YORK



YORK ENCLOSED MACHINE

Canadian Representative:

CANADIAN ICE MACHINE COMPANY
TORONTO: Villiers and Munition St., Eastern Harbor Terminals.
MONTREAL: .....324 Craig St. West
WINNIPEG: .....85 Lombard St.

RELIABLE REFRIGERATION
For Every Practical Purpose

The governing factor in the selection of Refrigerating Equipment, in most cases, is the reliability of the machine. Can it be absolutely depended upon to perform the work? A shut-down during the warm season is always annoying and often is an item of expense, due to loss of production or deterioration of products in storage.

York Refrigerating Machines have demonstrated their absolute reliability by more than thirty-five years of satisfactory service, which has given them a high reputation throughout the refrigerating field.

Ice and Ice Cream Manufacturers, Meat and Produce Dealers, Creameries, Dairies, Confectioners, Grocers and many other industries are using York Mechanical Refrigeration profitably in the production and marketing of high grade products. If you require Refrigeration in your business, we should be pleased to have you investigate the York System.

YORK MANUFACTURING CO.

(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA., U. S. A.

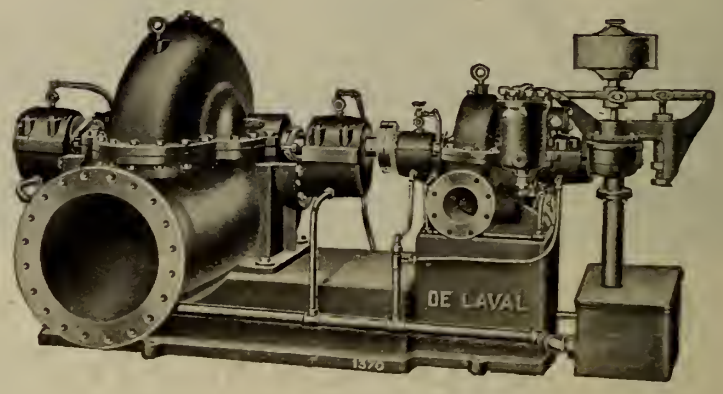
There is a YORK Plant to fit Your Business

Turbine-Driven Blowers Must Be Rugged

THE DE LAVAL TURBINE-DRIVEN BLOWER unit shown is designed for gas plant work. It serves, however, to illustrate the care taken in designing De Laval apparatus to insure continuous, satisfactory service. Note the heavy construction of all parts, including the blower casing, also the forced lubrication with sight feed and the powerful and accurate speed governor, all features contributing to reliability in operation.

The same features are apparent in the design of all other De Laval apparatus, including turbine-driven generators, centrifugal pumps, blowers and compressors, speed-reducing gears, geared turbines for rope and belt drive, etc.

State class of apparatus in which you are interested and appropriate literature with special data will be supplied. Ask for Catalog F--100.



De Laval velocity-stage turbine driving single stage gas blower; 11,000 cu. ft. of free air per min. against 33 in. water column at 3,600 R.P.M.

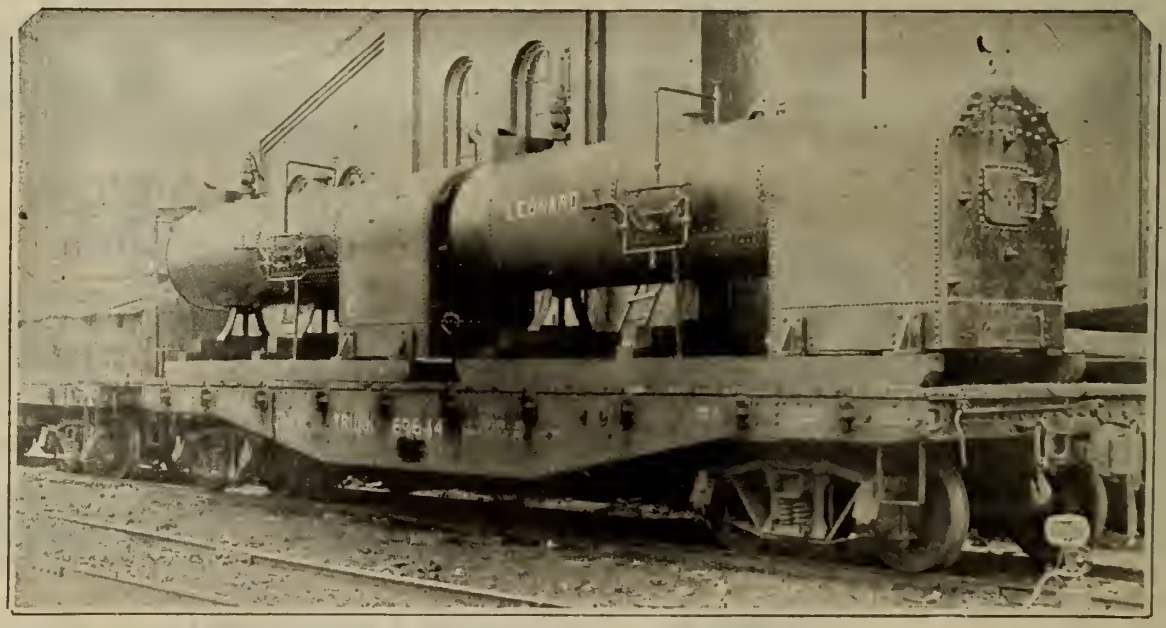
DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LIMITED
73 King Street West, Toronto

THE E. LAURIE COMPANY
243 Bleury Street, Montreal

TAYLOR ENGINEERING CO., LTD.,
Vancouver

158



Two 60 H.P. Locomotive Boilers for 125 lbs. Under Ontario Regulations.

E. LEONARD & SONS, LIMITED
Head Office and Works: London, Canada.
Branches and Agents from Coast to Coast.

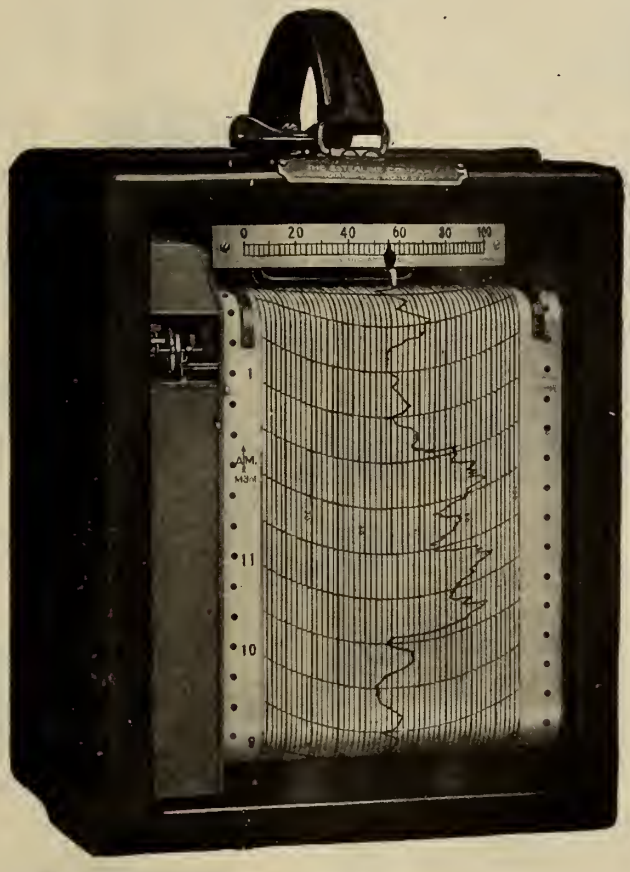
Established 1834

LEONARD

ESTERLINE

TRUE RECORDING INSTRUMENTS

Portable and Switchboard Types



Graphic Wattmeters **Graphic Voltmeters** **Graphic Power-Factor Meters**

¶Ideal for generating stations, sub-stations, industrial and isolated plants where the value of a true load curve cannot be overestimated.

¶The Illustration shows one of the Portable Graphic Meters, which is placed in an aluminum case with a glass face. The clock has an eight-day lever movement controlling the chart which is six inches in width and twenty-six feet long. A special inking device has been arranged for the marking of these charts. The holder will contain a supply for eight days and the ink is drawn through a tube to the pen by capillary action.

Write our nearest House for full information

Northern Electric Company
LIMITED

Montreal Quebec Toronto London Windsor Regina Edmonton
Halifax Ottawa Hamilton Winnipeg Calgary Vancouver

MAN'S ENEMY

Fire is man's eternal enemy although it is his servant.

He lives in dread of it. Constant association tends to make him careless, and he often neglects to prevent it from becoming his master.

BE PRUDENT

Install "ALMETL" Fire Doors and Shutters on every opening in your plant and confine incipient fires to their place of origin.

These doors are built of heavy, galvanized, corrugated steel — the fire resisting metal. The panel is bound in 3/16 ins. by 2½ ins. bar steel, ensuring strength and rigidity. "ALMETL" fire doors are built to give years of continuous protective service. THEY LAST.

Approved by the Underwriters

SOLE CANADIAN MANUFACTURERS

Geo. W. Reed & Co., Limited

Montreal

HOMESTEAD
Quarter-Turn Valves

Eliminate
Waste Time
and Leakage

HOMESTEAD Valves close with a quarter-turn and remain tight without dripping or leaking. A single quarter-turn of the lever opens them to a straight, unobstructed flow.

Made in straightway, threeway and fourway patterns for air, steam, water, oil, gas or acids. Catalog upon request.

Homestead Valve Mfg. Company
Homestead, Pa.

At Lexington, Kentucky.

For emergency a **Sterling** driven pump.

THE ENGINE of REFINEMENT
For the finest boats that float

Is **Your** Power Certain?

Model GRC 8 cylinder Sterling engine direct connected to two 10 in. Cameron centrifugal emergency pumps (3,000,000 gal. per day) at Lexington Hydraulic & Mfg. Co., Lexington, Ky. For domestic service the two pumps operate either singly, in series or in parallel, delivering 3,000,000 or 6,000,000 gal. per day against a total head of 150 ft. including 10 ft. suction lift at a speed of 1250 R. P. M.

For fire service, by proper manipulation of the valves, pumps will operate in series, together delivering 3,000,000 gal. per day against a total head of 300 ft. at a speed of 1250 R. P. M. requiring 205 B.H.P. Specifications by Alvord & Burdick, Chicago.

Catalog and recommendation on request.

Sterling Engine Co. **Dept C** **Buffalo, N. Y.**

High duty gas and gasoline engines - - 12 to 300 H P.

When that arch burns out

DON'T SHUT DOWN

but while continuing to carry your load make quick temporary repairs with

PLIBRICO JOINTLESS FURNACE LINING

Then as soon as opportunity offers put in a complete PLIBRICO setting—front and back arches, baffles, side walls, bridge walls—and **you will need no further repairs.**

Send for our book L-42 on "Modern Furnace Building."

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

DISTRIBUTORS:

Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd. Toronto, Ont.; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman, Clancey & Grindley, Calgary, Alta.

JOINTLESS FIRE BRICK CO.
1142 Clay St., Chicago, Ill.

STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN

DUPLEX POWER PUMPS

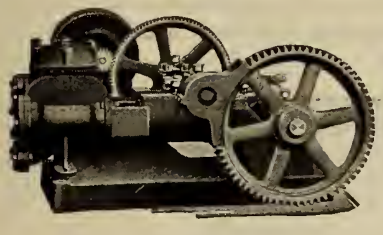


FIG. 7404

Made in piston and outside center packed plunger pumps for both top and side motor mounting.

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

Close Regulation

of Steam-Driven Boiler Feed Pumps

Hand control of steam-driven turbine pumps is not successful. The turbine needs a constant load for efficient operation. A sensitive, AUTOMATIC control is the only reliable way to maintain a constant load.

FISHER

Excess Pressure Governor

(Type 4)

is designed to render this accurate, automatic control.

It will maintain a fixed or overpressure in feed lines regardless of variation in steam pressure. It will do so under all conditions either on the ordinary plunger for steam-driven turbine type of boiler-feed pump. It will work satisfactorily whether supplying one or a battery or boilers.

It is recommended for use in conjunction with automatic feed water regulators.

The valve body is of our standard type of construction; the control is of the diaphragm actuated type.

Valve and seat rings are cast from our special formula, hard phosphor bronze which resists corrosion and wire-drawing.

Write for Bulletin No. 101. It contains full information about the Fisher Excess Pressure Governor and other Fisher Pump Governors.

The Fisher Governor Company
926 Fisher Ave., Marshalltown, Iowa

Agencies in all principal cities.

FISHER
TRADE MARK REGISTERED

KEEP YOUR BOILERS CLEAN
TO SAVE FUEL

⅛-inch Deposit on Tubes Increases Coal Consumption 30%
¼-inch Deposit on Tubes Increases Coal Consumption 66%
½-inch Deposit on Tubes Increases Coal Consumption 150%

MILLER'S
BOILER CLEANING EXTRACT

Will remove ***all*** deposit in any boiler and will prevent ***any*** deposit forming in any boiler, no matter what the water supply is, ***without damage*** to Tubes, Joints, Brasses or Packing.

TRY A CASK!

R. C. Miller Oil & Supply Company
38-40 Youville Square, MONTREAL

124 HOUR TEST IN PROMINENT PLANT

COKAL HAND STOKER		
Water Evap.	891812.5	lbs.
Coal Burned	87779.	lbs.
Ash	10504.	lbs.
Percent. of ash	11.95%	
Pressure	165	lbs.
Feed Water	213	deg.
B. T. U.	14140	lbs.
Evap. per lb. of Coal as fired	10.16	lbs.
Equiv. Evap. from and at 212 deg.	10.64	lbs.
Efficiency	73	%
SHAKING GRATE		
Water Evap.	718062.5	lbs.
Coal Burned	79380.	lbs.
Ash	9921.	lbs.
Percent. of ash	12.5%	
Pressure	165	lbs.
Feed Water	213	deg.
B. T. U.	13977	lbs.
Evap. per lb. of Coal as fired	9.049	lbs.
Equiv. Evap. from and at 212 deg.	9.47	lbs.
Efficiency	66%	

SAVING BY COKAL HAND STOKER 12.3%

Horse Power developed with COKAL Hand Stoker 218
Horse Power developed with Shaking Grate 176
Increase in Capacity with COKAL Hand Stoker, 24 Per Cent.

Gelinas & Pennock, Regd.
207 St. James St. - MONTREAL

SPECIAL NOTICE TO SUBSCRIBERS

We have received some complaints from subscribers to the effect that Power House is not being delivered. In almost every case investigation has shown that our friends have changed their addresses and have NOT notified us.

Let every subscriber look at the address on the label on this issue of Power House, and if it is not correct, please fill in and mail to us the following—

Name .....

Old Address .....

Change to

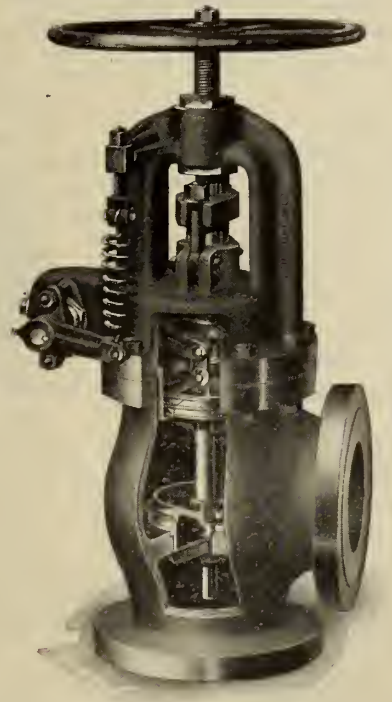
New Address .....

Occupation .....

Address "Power House"
143 University Ave. Toronto, Ont.

LUNKENHEIMER

Safety Non-Return Valves



Proper regard for the protection of life and property demands the installation of safety devices of established merit.

The Return Valve being second only to the Pop Valve as a boiler safety device, great care should be exercised in its selection.

Lunkenheimer Safety Non-return Valves have proved their reliability through many years of service and are warranted to perform all that is claimed for them.

They will automatically close and instantaneously cut out a boiler connected in battery when the pressure within the boiler suddenly drops below that in the header; they facilitate the operation of other boilers in battery, and they will enable the plant operatives to safely pursue their duties and will safeguard the life of a human being who may have occasion to enter a dead boiler should the regular stop valve fail or be opened through carelessness.

Lunkenheimer Safety Non-return Valves may be connected with the stem pointing vertically upward or horizontally.

All parts subjected to wear, including the disc and seat, are renewable and the seating surfaces are regrindable.

For service and reliability, specify "LUNKENHEIMER."

Distributors of Lunkenheimer Products situated in every commercial center.

THE LUNKENHEIMER CO.

"QUALITY"

LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD

NEW YORK CHICAGO CINCINNATI BOSTON LONDON

EXPORT DEPT. 129-135 LAFAYETTE ST. NEW YORK

8-23-43

CURRENT EDITION OF CATALOG BEARS No 58 COPIES PROCURABLE FROM LUNKENHEIMER DISTRIBUTORS

The Romance of the Advertising Pages

By F. A. McLean

LAYING aside for a moment the usual dollars and cents angle of advertising, have you ever stopped to consider the advertising pages of your magazine or trade paper from their human interest point of view?

Now an advertisement is just as much a news item as a notice in your home town paper that Sallie Jones was married in a red hat and that she is going to live in Podunk after the honeymoon, or that Bill Bailey lost three fingers last Friday while trying to clean the teeth of a buzz saw and swears that next time he tries it it won't be on a Friday.

The ads. tell you who, why, where, when and what and they come mighty close to us because they speak in a language that we know, the language of our hobby or our business.

Many of the brightest lights of our modern literary world are not too proud to write advertisements, or our famous artists to illustrate them. Where but in the advertising pages can we find finer examples of that almost extinct art of the etcher and the wood engraver?

Advertisements must compete for attention with the news pages, editorials, the stories, the articles and the pictures in the body of the magazine or the trade paper. Hence nothing is too good or too costly to illustrate the ads., which are often the finest examples of the best work of our photographers and photo engravers to-day.

So fine are some of these illustrations, and so beautifully worded and illuminated the texts, that they rank with the best in literature and art that have come down to us through the ages. In the colored inserts of our magazines we find reproduction of cakes, candies and other goodies, so resplendent and so natural that our mouths water, figures and faces of men and women so natural that we want to smile or cry when they do, look to see what they are looking at, gloves and clothing so realistic that we feel like picking them off the pages and putting them on, etc.

Let us imagine what we could do, you and I, if we had an Aladdin's Lamp and could bring all of the people, shops, machines and other products out of the pages of a single issue of Canadian Machinery and place them along a single city street.

Wouldn't it be a tremendously long street, and how interesting it would be to go down one side of this street and up the other, looking at all the wonderful array of people, shops and goods displayed? Just think how much we could probably learn with little or no trouble in a single trip.

Or let us shift the scene and let's pretend for a few minutes that we are back in the middle ages, and that each one of the ads. represents a town crier or a roadside stand. What an experience it would be to walk along listening to this great army of criers calling our attention to their masters' goods in all the varying tones, high, medium and low, which such a throng might be expected to use!

Or coming nearer home, let's go back a few years to the time we pitched marbles in the streets or played "Chaw Raw Beef" by the "Ole Swimmin' Hole," and imagine a circus coming to town—and such a circus as it would be if all the ads. could come to life and all their characters and products step down from the printed pages and form up in the grand parade!

How we, and other youthful "Captain Kidds," Jesse Jameses, and "Rain in the Faces" would have followed that parade and how quickly would the elephant, the clown, the painted lady and the fat man have been forgotten amidst such an array of wonders!

When you read the ads. you gain the pleasure and profit of clear thinking and store up in your memory for future use, for yourself or your friends, the endless supply of interesting and valuable information they contain.

Read the advertisements in your magazines, your newspapers, your trade journals—for the news they contain—for their educational value—for the life, vitality, art, wit and humor to be found in them—to raise your ideals and to guide you in your family and business affairs.

Here is what I found in a recent issue of CANADIAN MACHINERY:

Why I need a good die stock if I need one at all.

The story of a drill which worked for a piano company for two years without any trouble.

Some interesting facts about a town in Quebec.

How fast a hack saw should cut when in proper condition.

The solution of a brass working plant's cleaning problem.

What Canada's steel mills are making.

The clutch I should use for the place that's hard to get at, or where space is scarce.

The tale of a miller that keeps five die-sinkers busy and has been doing it for four long years.

The kind of machinery that should be used to grind parts with accuracy and despatch.

Vanadium and its effect on steel.

A metal that has mastered all other metals.

The kind of tools that are used in Canada's great logging camps.

The story of Mr. Punch and his fifteen hundred good tools.

The why and the wherefore of goggles in industrial plants.

A method by which drilling time may be cut from 20 to 2 minutes.

How motor truck makers grind their shafts.

A belt that will stand up under steam without going to pieces.

Why Gisholts are so successful.

One method that enabled a manufacturer to increase his production by 220 per cent.

A little detail in the construction of a wire fence that makes it stand up well.

The furnaces in which nichrome, the master of oxidation and heat, is made.

A conveyor belt that gives exceptional service because it is built like an automobile tire.

A means of cutting down overhead expense by using the right kind of hoisting and handling equipment, and many equally interesting and helpful pieces of news, human interest stories, etc.

Dart Union Pipe Couplings will not leak

Easily Connected

The Face and Seat being Ball-shaped permits easy and perfect connection even if pipes are out of alignment.

All threads are exact to standards and are clean and full.

Dart Unions are made in a variety of styles to fill all requirements.

Will Never Wear Out

Bronze meets Bronze at the joint, a feature that removes all possibility of deterioration at the vital part.

The Heavy Iron Parts will not stretch or pull apart, or become distorted when connecting up with a pipe line.

Sold by all Jobbers

Manufactured by

Dart Union Co., Limited

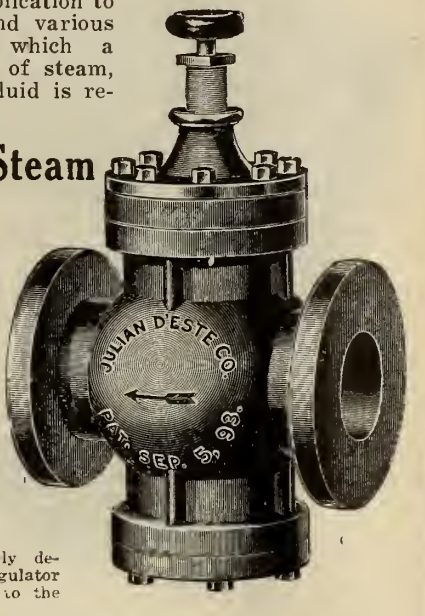
TORONTO, ONT.

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal; is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: { 180 WASHINGTON ST., NEW YORK CITY.
318 W. WASHINGTON ST., CHICAGO, ILL.

Canadian Association *of* Stationary Engineers

Incorporated May, 1887
Incorporated at Ottawa June, 1917

This Organization is founded on the following principles:

—The better education of its members in the science of steam engineering.
—To protect the competent engineer and his vocation.
—To enroll all competent engineers in this organization.
—To impart information beneficial to the profession.
—To assist members out of employment to obtain the same.
—To procure by legal enactment greater safety in the operation of steam plants.
—The belief that knowledge and ability of one's profession is what is necessary to make success possible.

Brother Engineer:

Did it ever appeal to you to join an association devoted entirely to the interests of the engineering profession; one which by means of lectures, illustrated and otherwise, delivered in the lodge room, tends to keep its members right up to the minute with the progress made in the engineering professions?
If you are interested in an association of this kind, and live where less than fifteen engineers reside, send for a copy of our constitution, and make application to the nearest lodge for membership. If you live where more than fifteen engineers live, get together and send in a written application to me.
The undersigned will be very pleased to give any further information required.

F. HARPER, President Grand Lodge.
89 Bay Street, Kingston.

L. J. ELLIS, Sec.-Treasurer Grand Lodge.
142 East Avenue, N. Hamilton.

This Bulletin Points a Way to Boiler-room Economy

The crying need of the world to-day is ECONOMY —and still MORE ECONOMY—coupled with greater efficiency in production.

There is a host of ways to arrive at the much desired result, of course.

One of them—a tremendous help in reducing boiler-room losses—is the Vulcan Soot Cleaner. It reduces stack temperature, increases steam capacity and production, and decreases fuel consumption.

Send for a Vulcan Bulletin and let it show you how and why Vulcan Soot Cleaners are a vital necessity in the modern boiler-room.

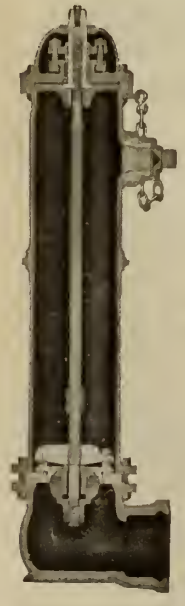
The Bulletin shown describes the Vulcan Soot Cleaner for Stirling boilers. Other Bulletins are: No. 541, for B. & W. boilers; No. 547, Wickes; No. 550, Connelly, Badenhausen and Erie City Vertical; No. 552, Edge Moor; No. 556, Keeler, Geary and Union; No. 534, Return Tubular.
Ask for the one for YOUR boilers.

The VULCAN SOOT CLEANER COMPANY
MAIN OFFICE DU BOIS PA. OFFICES IN THIRTY CITIES

WINNIPEG
William W. Hicks & Co.
567 Banning St.
Beveridge Supply Co., Ltd.

TORONTO
Green's Economiser Ltd.,
Kent Building
MONTREAL

Made in Canada



DARLING
PATENTED
Fire Hydrant
The Perfect Hydrant for all Purposes

Compression Valve—Closes with the pressure and prevents water escaping should barrel be broken above valve.

Large Barrel—Delivers water to nozzles with no loss of pressure.

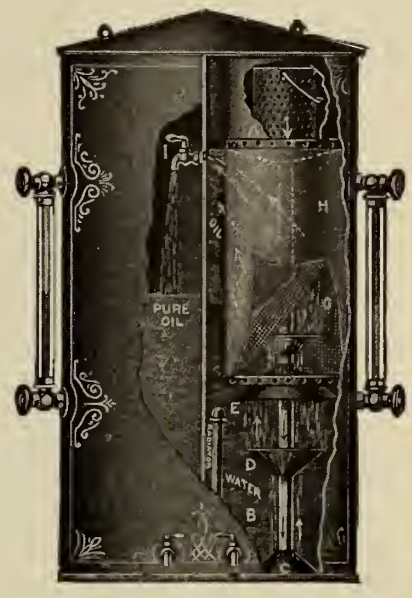
Internal Parts—Including Main Valve and drip valve seats easily removed through top of hydrant.

Operating Threads—Are at top of hydrant, protected from injury and accessible for lubricating.

Licensed Manufacturers in Canada under Darling patents

DOMINION STEEL PRODUCTS CO., LIMITED.
BRANTFORD - ONTARIO

SIMS *Style A* OIL FILTER



Like All Sims Lines:

Thoroughly Dependable

AS THE function of an oil filter is to remove the impurities from the oil, three important features must be considered in the selection of this apparatus; first, means to be employed to remove the impurities; second, cost of filtering material; third, attention and time required for thorough cleaning. SIMS' STYLE "A" OIL FILTER MEETS the most exacting requirements in every respect and never fai'ls to prove an economical and efficient utility.

These filters are made in several sizes to meet various requirements, among them a small size designed for users of small power plants, gas or gasoline engines. Is there any further information you wish? We will be glad to answer any questions and furnish booklet containing a description of this thoroughly dependable oil filter.

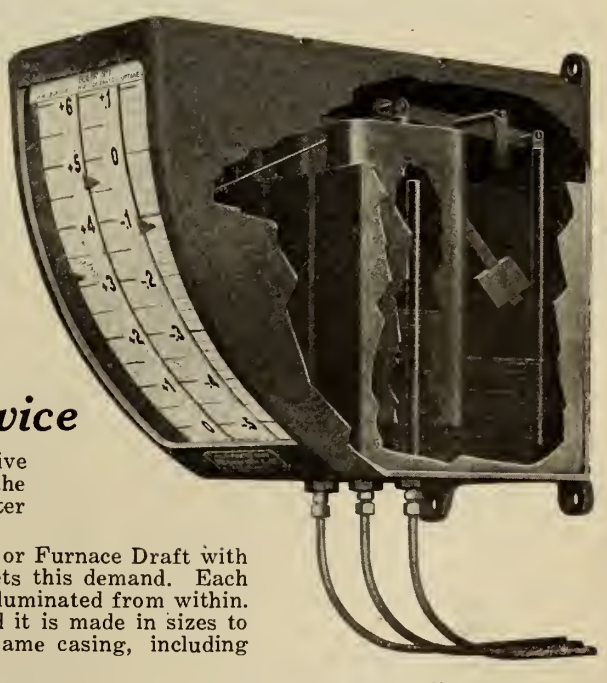
THE ARTHUR S. LEITCH COMPANY

Limited

1001-2 KENT BUILDING, TORONTO, ONT.

BAILEY

Multi-Pointer GAGES



Distinctly New and Valuable Device

These Gages were developed to supply a demand for a sensitive and accurate draft gage. The design is practically the same as the Fire Box Draft Indicator which has been in use on our Boiler Meter for several years.

With forced draft it is highly necessary to maintain the Fire Box or Furnace Draft with an accuracy of 0.01 inches of water. The Multi-Point Gage meets this demand. Each pointer has a 10-inch motion along the arc of a scale which is illuminated from within. The gage can be read with accuracy at a distance of 20 feet, and it is made in sizes to accommodate any required number of separate pointers in the same casing, including 2, 3, 4, 6, 8, 10 and 12 pointers.

There are two distinct types of casing used, one for wall mounting, known as Type P2, P3, etc., depending on the number of pointers, and the other design for meter board mounting, known as Type P2F, P3F, etc. The gage is so convenient and easily read that it will be developed to show high pressures, temperatures, stoker speeds and other factors, thus indicating on one instrument all secondary operating conditions.

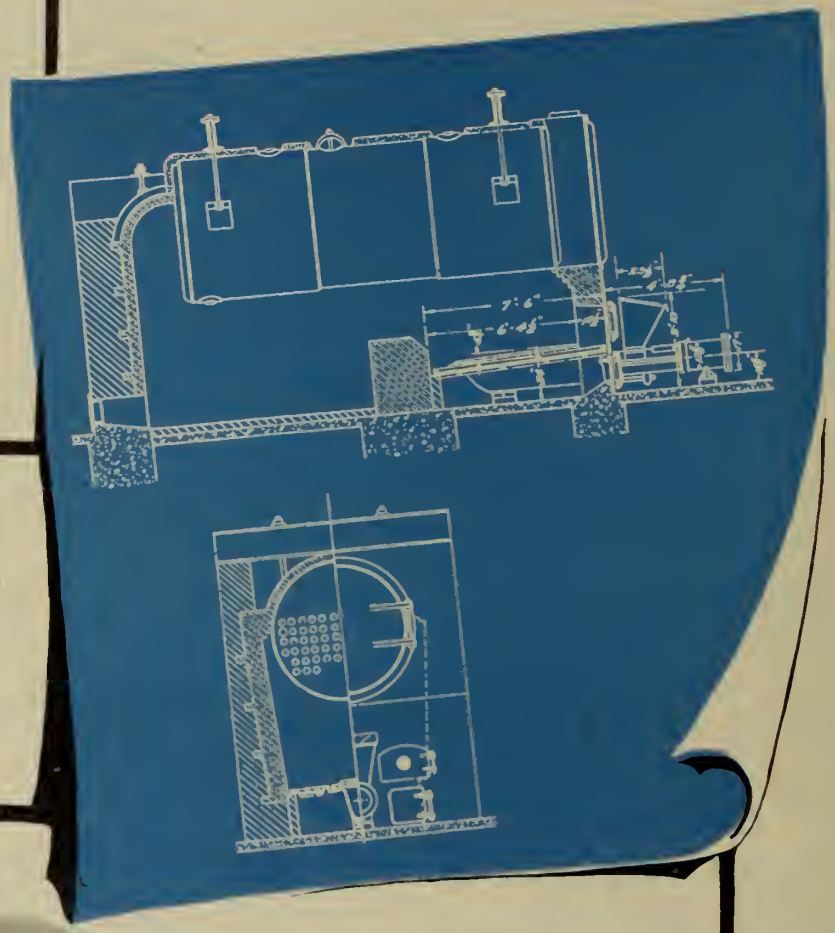
This distinctly new gage is fully described in Bulletin No. 160—shall we send you a copy?

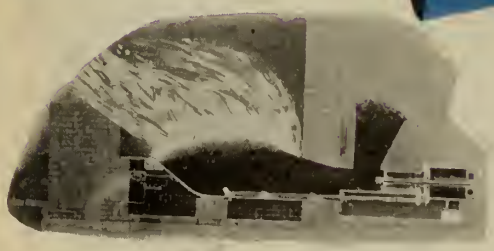
BAILEY METER COMPANY

2001 E. 46th Street, Cleveland, Ohio

First Choice

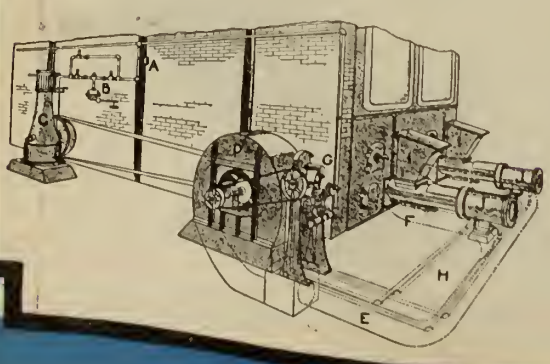
More Jones "Standard" Stokers Are Installed with R. T. Boilers Than All Other Makes of Stokers Combined





The vertical and longitudinal sections through the stoker and furnace (above) illustrate the "Standard" Stoker's operation. Note that the tuyere openings are above the fresh fuel in the retort, but below the fire. As the ram and pusher rod move the fuel through the retort, the volatiles are thoroughly distilled by the heat of the fire above and are entirely burned.

By the time the coal reaches the combustion zone it has become coked; so the released volatiles are burned in connection with coked coal. Naturally, this means efficient and smokeless combustion.



The drawing (opposite) shows the arrangement of the draft, blowing, and automatic-controlling mechanisms. The speed of the fan engine (C) is varied according to changes in the steam pressure by means of the fan engine regulator (B). This engine drives the blower to which is belted the Cole automatic valve. The Cole valve controls the steam supplied to the pistons (J) and this controls their rate of operation and the rate of fuel feed.

The air and fuel supply are thereby automatically controlled, so that an even steam pressure is maintained regardless of load fluctuations. Since the amount of coal supplied varies directly with the volume of air provided by the fan, high efficiencies are obtained at all times.

The Canadian Stoker

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Jones "Standard" Stokers

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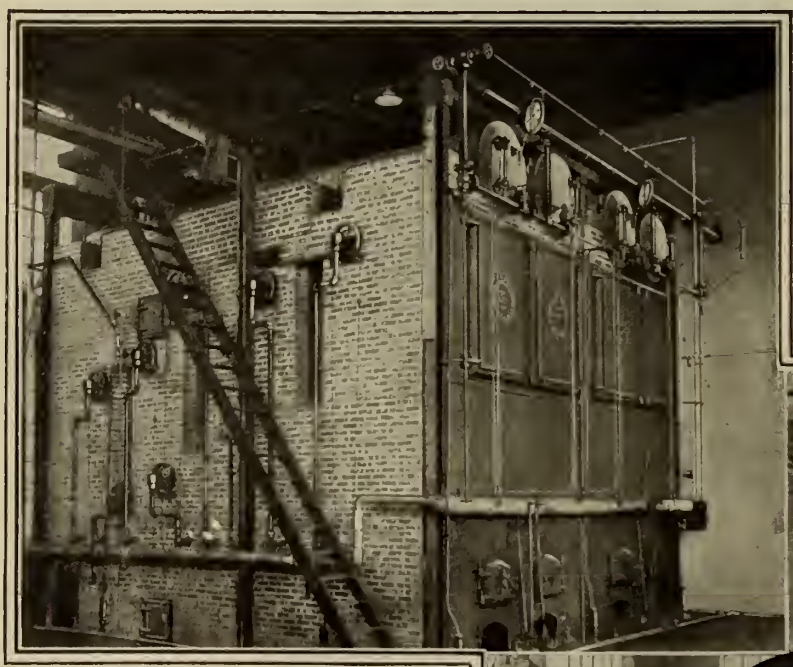

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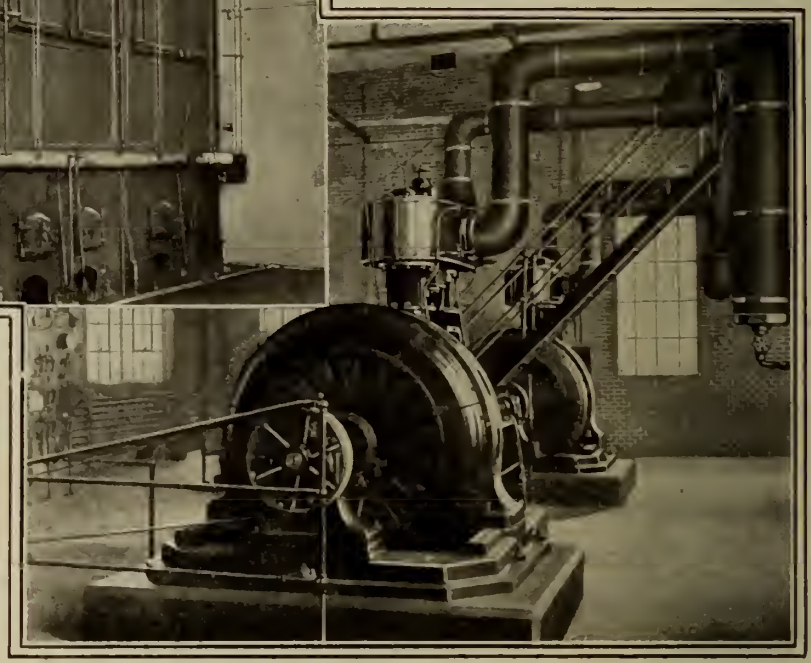

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The Economy of Working with Back Pressure

In Cases Where Steam at a Higher Temperature Than 212 Degrees, but Within Reasonable Limits is Required, a High Back Pressure on the Engine May be More Economical than Using Reduced Steam from the Boiler

By T. H. Fenner

A QUESTION that often arises and is the subject of much doubt among operating engineers, is that of the effect of carrying a high back pressure on the engine. This back pressure is required for the purpose of supplying steam to the radiation of the building, and sometimes for process work such as heating, dye tanks, lumber drying, etc. The question in the mind of the engineer is whether it is better to carry a higher back pressure and use the exhaust steam, or to supply the steam through a reducing valve direct from the boilers. The subject is one that deserves a little study.

Steam Per H. P. Hour

Suppose that the engine is of the single cylinder non-condensing type, and has a consumption of 30 lbs. steam per indicated horse power per hour. Now just what do we mean when we say that the engine has a consumption of 30 lbs. steam per I. H. P. per hour. Do we mean that it requires that weight of steam to perform the work done by the engine, or that the heat units contained in that quantity of steam are necessary for the production of the horse power delivered by the engine? Let us examine a horse power in the light of the heat units it contains. One horse power, we know, is the performance of 33,000 foot pounds of work in one minute. Now the first law of thermo dynamic tells us that each unit of heat requires for its production or gives up in its dissipation 778 foot pounds of work, and that heat and work are mutually convertible. This means that for each horse power there is required 42.416 B. T. U. per minute, or 2545 B. T. U. per hour. Now then if the steam is supplied to the engine at 100 lbs. gauge pressure, and exhausted at one lb. above atmospheric pressure, we can see what quantity of heat is contained in the steam, and what proportion of this heat is actually used by the engine. Steam at 100 lbs. gauge pressure contains 1188.7 heat units, and steam at one pound above atmospheric pressure contains 1152 heat units. That means that when the exhaust opens every pound of steam contained in the cylinder escapes into the atmosphere with 1152 of its 1118.7 heat units still available. Now if each pound of steam contains at its entry into the cylinder 1188.7 B.T.U., and the production of one horse power requires only 2545 B.T.U., it is evident that the heat equivalent we receive is only that contained in 2.13 lbs. of steam per hour. In other words there is enough heat in 2.13 pounds of steam at 100 lbs. gauge pressure to produce work at the rate of 33,000 foot lbs. per minute for one hour. Yet to do this work we have to pass through the engine we speak of no less than 30 lbs. weight of steam per hour, and we have available at the exhaust in each pound of steam 1152 heat units, or for each horse power the engine produces $1152 \times 30 = 34560$ heat units. If the engine is 100 horse power that means we throw away in exhaust 3,456,000 heat units per hour.

Heat and Temperature

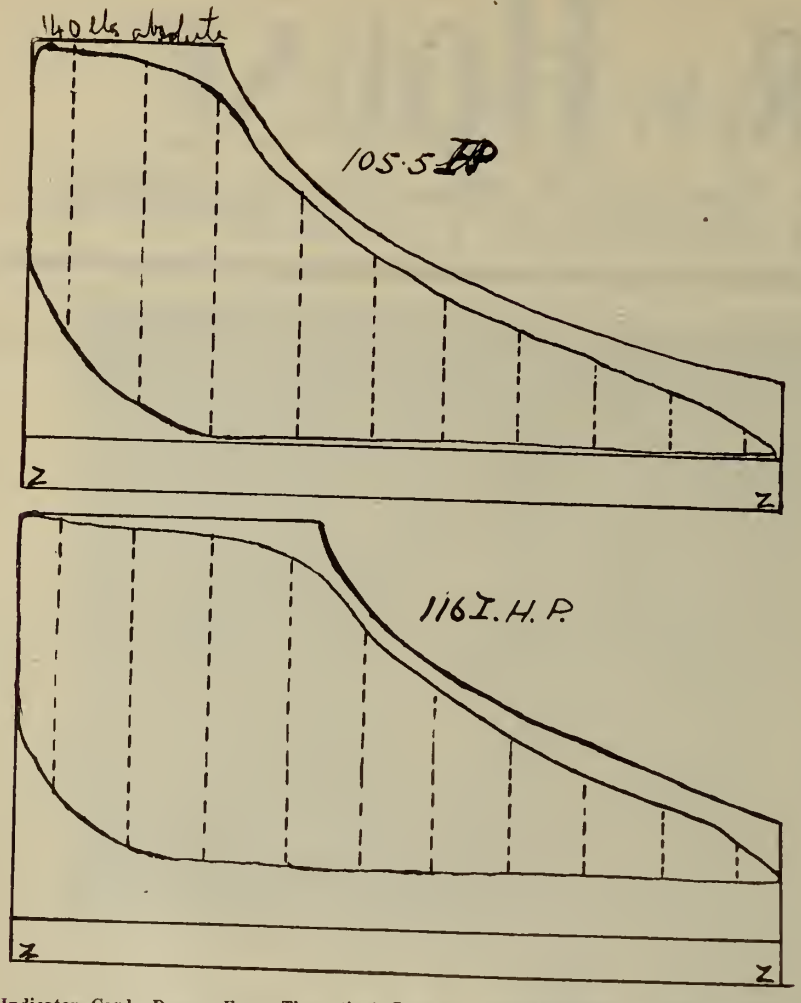
We have considered the heat available in the foregoing without reference to the temperature, but if we are going to see what possibilities the exhaust holds for us, we must examine it from the viewpoint of sensible heat. Sensible heat is temperature, and in the present state of human development, the use we can make of masses of heat depends entirely on the level of temperature that they are at. For instance, there is quite a large quantity of heat present in a field of ice, but it is at such a low level of temperature that with the heat engines we have available it is of no use to us. The same amount of heat, contained in a much less weight of steam, but at a much higher temperature level, would be of infinitely more use to us, as we could apply it to a steam engine piston or turbine rotor, and turn it into power. True, we should lose a very much larger percentage of it than we should make use of, but we could turn some of it to useful work. This is the effect of temperature. Now when we come to problems of heating such as the heating of a building, or the heating of water tanks, we have to consider the requirements from a temperature standpoint and not from that of heat alone. This applies more particularly to the question of heating lumber drying kilns, japan ovens, etc., where high temperature is a manufacturing necessity. For instance, the temperature of exhaust steam is always high enough for the ordinary heating of a building, and also for heating water by direct mixing, because the highest temperature obtainable applied to water at atmospheric pressure will not raise its temperature above 212 degrees. However, if you have lumber kilns or japan ovens for instance that require a temperature of say 250 to 300 degrees to perform the work within a specified time, the temperature of the heating medium must be raised accordingly. The same amount of heat could be supplied by exhaust steam at 212 degrees but it would take a longer application on account of its lower temperature.

Thus we see that there is a very great necessity to distinguish between sensible heat, or temperature, and total heat which is the sum of the sensible and latent heat, and represents the ultimate possible amount of heat available.

Heat Efficiency

In the engine we have been discussing, the steam is supplied at a temperature of 337.4 degrees Fahrenheit, and a latent heat of 880.4 B.T.U. the total heat in the steam above 32 degrees being 1188.7 B.T.U. This steam is expanded in the cylinder, giving up heat in work on the piston, and also losing some by radiation, etc., until it is exhausted at a temperature of 21 degrees, and a latent heat of 967.6 B.T.U. or a total heat above 32 degrees of 1152 B.T.U. We see then that while the temperature has dropped, the latent heat has increased. The total heat has of course decreased by the amount used by the engine.

The efficiency of any heat engine from a thermal point of view depends on the range of temperature, or temperature drop in the heat medium, measured on the absolute temperature scale. The greater the drop in temperature the greater the efficiency, the percent-



Indicator Cards Drawn From Theoretical Curve to Illustrate Effect of Back Pressure.

age of efficiency being calculated from the formula

$$\frac{\text{Heat received—Heat rejected} \times 100}{\text{Heat Received}} = \text{Useful Heat Percentage}$$

Putting this into figures we have, using absolute temperatures which are equal to Fahrenheit temperature plus 460

$$\frac{797.4—673 \times 100}{797.4} = 15.5 \text{ per cent}$$

The above is the thermal efficiency in the engine cylinder itself, and considering only the steam after it has entered the cylinder. That is we are not taking any acount of the heat put into the steam in the boiler. Now if we have feed water entering the boiler at 180 degrees F. we have put into each pound of steam at 100 lbs. gauge pressure 1008.4 heat units.

At 30 lbs. steam per I.H.P. per hour we are using ½ lb. steam per minute or 504.2 heat units. We have seen that one horse power is the equivalent of 2455 B.T.U. per hour or 42.416 B.T.U. per minute. Therefore we are getting in work only 42.4 divided by 504.2 or .084 x 100 = 8.4 per cent. of the heat put into the steam in the boiler.

Now if we can utilise the heat of the exhaust steam after it leaves the engine, we can then only charge the engine with the actual amount of the heat it uses, instead of the whole amount of steam that passes through it. This is a point that is not fully realised by a great many engineers. They will say that increasing the back pressure of the engine, means that for the same cut off there is less power, and in order to get the same power with the back pressure more steam must be used, that is a later cut off must be allowed. Now the point is this, that although more steam may pass through the engine, the engine actually only uses the same amount of steam to deliver a horse power, and the heat is still available at the exhaust for other purposes.

How It Works

Let us take an example, and work out the results from the indicator cards of an engine working under different conditions of back pressure. We will assume that the exhaust is needed for heating a building, and therefore the temperature of steam at atmospheric pressure will be ample. We will take as a typical case a small plant where the engine is of 100 horse power, steam, being supplied at 125 lbs. gauge, exhausting into the atmosphere or into the heating system as required. We will assume that a portion of the exhaust is used for heating the feed water from 50 degrees to 200 degrees. We are not concerned here with the boiler or furnace efficiency, that is we do not take into account how many heat units go into the furnace to produce the steam, but only the heat units contained in the steam as it leaves the boiler.

We will assume the engine to be 18 inches diameter, by 24 inches stroke, running at 60 revolutions per minute, with an initial pressure of 125 lbs. gauge and cutting off at about ¼ stroke. We can now construct an indicator card from these particulars, and obtain the theoretical expansion curve, and from this the probable actual performance curve. From this we can get the steam consumption with the cut off and exhaust at normal, and then see what effect increasing the back pressure will have.

With a mean effective pressure of 56 lbs. per square inch we get a horse power of 105.5, with a steam consumption as estimated from the indicator card of 21.7 lbs. per I.H.P. per hour. This is better than we would get from an actual engine of the dimensions given, but will do for the purpose we have in mind.

We have then put into the steam in the boiler, or into the boiler feed water to turn it into steam at the pressure required 1024.2 B.T.U. Exhausting at one pound gauge above atmosphere we have available 1152 heat units, but we have put 150 heat units into the feed water before it went into the boiler, and this must be subtracted from the heat available in the exhaust steam, or added on to the heat put into the feed water in the boiler. It comes to the same thing as far as the heat used by the engine goes, but for the sake of clearness it is perhaps better to include it in the heat delivered to the engine. We have then 1174 heat units in each pound of steam supplied to the engine, of which but 22 are used while passing through the engine.

Deducting the 150 heat units which we are going to use to raise the feed water temperature from 50 to 200, we have 1002 heat units at a temperature of 212 degrees available for heating purposes in every pound of steam. As we are using 21.7 lbs. steam per I.H.P. per hour, and developing 105 horse power, we have available 2278.5 lbs steam per hour. Multiplying this by the available heat in each pound of steam we have in actual heat units 2,283,057 per hour. If we are going to use the exhaust steam for heating a building by means of direct radiation, and can reckon on radiators giving off about 250 B.T.U. per square foot surface per hour, we will have enough heat, neglecting losses between the engine exhaust and the radiating surface to supply 9132 square feet of radiating surface, with steam at atmospheric pressure. Now let us see what would happen if we had to supply this amount of radiation direct from the boiler, without passing the steam through the engine on its way. We can assume that the steam is supplied from the same high pressure boiler, but passes through a

reducing valve before going to the heating surface. We will assume that the feed water is supplied to the boiler 180 degrees, the probable temperature of the returns from the heating system.

We have then put in each pound of steam in the boiler at 125 lbs. gauge, 1044 B.T.U., and the steam contains 1192.2 B.T.U. To supply 9132 square feet of radiation using 250 B.T.U. per square foot per hour, and neglecting losses between the boiler and the radiation, we shall require 1915 lbs. steam per hour. Now we have only to add 363.5 lbs. of steam to get our heating and 100 horse power as well, so it is evident that there is a considerable advantage in using exhaust steam, when it is available. As a matter of fact, the radiation losses will be greater between the boiler and the heating surface when live steam is used through reducing valve, as the steam will be at a higher temperature leaving the reducing valve and entering the steam main, than when exhaust steam is used. However we have not taken these losses into account in either case, but have assumed all the heat to be available at the radiating surfaces in the factory. This means that the engine has developed one horse power for about 3½ lbs. steam per hour.

Another Example

If we now consider a case where the steam is required for process work at a gauge pressure of 20 lbs. per square inch, such as in a paper machine, we wish to know whether it would be better to use a back pressure of 20 lbs. per square inch on the engine, or to run the engine with atmospheric exhaust, and supply the necessary steam through the reducing valve direct from the boiler. Let us see how much steam we would have to supply the engine with when working against this back pressure to get the same horse power.

We must increase the cut off in order to get the same mean effective pressure with the increased back pressure. Our mean effective pressure in the first case was 56 lbs. per square inch gauge, or 71 lbs. per square inch absolute, with a mean back pressure of 16 lbs absolute. We have to get the same mean effective pressure with an absolute back pressure of 35 lbs. or 20 lbs. gauge. This means that our absolute mean pressure supply plus the absolute back pressure will be 106 pounds absolute. This gives a ratio of mean to initial pressure of about .75, and the ratio of expansion corresponding to this will be about 2½. We can construct a theoretical curve using this as a base, and then draw what would be an approximate actual expansion curve, as we did before. Working this out we get a mean effective pressure of 62.4 and this gives an indicated horse power of 116. This is a little higher than we had at first, but it does not matter for purposes of comparison.

Taking the pressure at the point where release occurs, at about .9 of the stroke, we find it is 55 lbs. absolute. The weight of a cubic foot of steam at this pressure is .1285 lbs. and multiplying this by the volume of the cylinder multiplied by .9 we get the weight of steam per stroke.

Thus 1.5 x 1.5 x .7854 x 2 x .9 x .1285 = .398 lbs. This multiplied by 120 x 60 gives the pounds steam per hour, which comes to 2865.6 lbs., or a consumption of 24.7 lbs. per I.H.P. per hour. The exhaust pressure is 35 lbs. absolute, and the steam having expanded from 55 lbs absolute to 35 absolute without doing very much work after the exhaust port is opened, will have re-evaporated the moisture in the steam and may be considered as saturated steam at the final pressure. This contains 1166.8 B.T.U. per lb., which are available for heating. Multiplying this by the steam used per hour we have available 1166.8 x 2865.6 or 3,343,588.-08 B.T.U.

Now if we again consider that we take 150 B.T.U. from each pound of exhaust steam to heat the feed water to 200 degrees, we will have 2,913,742 B. T. U. to go to the machine.

Comparing again the steam we should have to supply for the same amount of heat units direct from the boiler we divide the total heat of steam at 125 lbs. gauge into the heat units required, neglecting losses as we have done all along. This shows that we shall require 2444 lbs. steam per hour for heating alone. Subtracting this amount from that required for driving the engine and heating as well we get 2865.6 less 2444 which leaves 421.6 lbs. per hour, for driving the engine, and this divided by 116 gives us 3.64 lbs. per I.H.P. per hour, which is nearly the same as before.

Comparing the Fuel Consumption

If we now consider these results in the light of fuel consumption, we shall have a good basis of comparison. In the first case we have the engine developing 105.5 horse power and using 2278.5 lbs. steam, supplying the heating surface with exhaust. We see that to supply the same amount of heating surface with direct steam we shall require 1915 lbs. steam. If we assume that each lb. of coal evaporates 9 lbs. water actually, we shal require to burn for driving the engine and heating the building 253.1 lbs. coal per hour. To heat the building alone would require 212.7 lbs. coal per hour, so that for 41 lbs. coal per hour more we get our power in addition to the heat.

In the second case we have 116 horse power from the engine with a back pressure of 20 lbs. gauge, and are supplying heat for manufacturing process with the exhaust. The steam consumption under these conditions is 2865.6 lbs. per hour, and expressed in coal consumption we have 318.4 lbs. coal per hour. To supply the same amount of heat to the machine without any power we have to use 2444 lbs. steam per hour, and this in terms of coal is 271.5 lbs per hour. Thus for 47 lbs. coal more we get our power.

The foregoing is an attempt to show in a simple clear manner the economy resulting from the use of back pressure on an engine for raising the exhaust temperature, where heating is required at a higher temperature than 212 degrees. It is of course to be understood that each case must be judged on its merits, but the idea that running an engine with a high back pressure must necessarily be uneconomical is wrong, and every engineer should understand clearly the principle involved. The engine must only be charged with the actual amount of heat that it uses to develop the horse power when the balance of the heat is utilised in some other process. Only when the exhaust is wasted, or ejected to the condenser, can the total amount of steam consumption be charged up to the engine.

CATALOGUES

The Pyramid Iron Products Corporation, 2 Rector Street, New York, have issued a bulletin describing their "Pyramid" grates, specially designed for the burning of the lower grades of anthracite screenings, silt, culm and lignite. The design of the bar is such that there is no direct vertical blast of air through the coal, but the air is delivered horizontally through the fuel bed. This tends to prevent the small stuff being blown off the bars. It is claimed that the bars can be made in comparatively light weights, without danger of warping or burning.

The Vasils Steam Systems Co., Washington, D.C., are putting on the market a stoker designed for hand or automatic operation, with dumping grates and a hopper feed, and have issued a bulletin describing and illustrating the apparatus. It can be changed from hand operation to automatic operation by fitting a shaft across the boiler front, and very successful results are claimed to have bee obtained from it.

Bernard H. Prack, architect and engineer, Hamilton, has issued a bulletin entitled Boiler House Economy, one of a series on the subject of power plant design. In this bulletin the features of a large number of power houses designed by the author are described, and their relation to the economical operation of the plants pointed out. A list of some of the large clients of the author is included, the object of the booklet being to show the importance of proper design of power plants.

We have received from the Plant Engineering and Equipment Co., their catalogue describing steam specialities, including Pecco steam trap gauges, Corliss Valve Steam Traps, Turbo Blowers, heating specialties, etc. The various specialties are illustrated, and there is a table on the back page showing flow of steam at various pressures, and factors for pressure drop in steam per 1000 feet. The address is 192 Broadway, N. Y.

Straight Flow High Lift Poppet Valve Engine

The Feature of this Engine is the Very Small High Lift Nozzle Disk Valve—This Enables a Very Small Amount of Clearance Being Used, Giving High Compression and Temperature

By J. Stumpf

LOSSES in steam engines are due to cylinder condensation, clearance space, throttling, friction, leakage, heat radiation, heat conduction and imperfect expansion. It is claimed that some of these losses are reduced in the engine about to be described.

The most characteristic element in this straight-flow, or "uniflow" steam engine cylinder shown in Fig. 1, is the very small high-lift nozzle-disk valve employed therein. It became possible to give this valve such small dimensions through the employment of a valve-gear shaft running at twice the speed of the main shaft. For an average cut-off of 10 per cent. the eccentric motion with the camshaft running at a speed of the main shaft will give a maximum valve lift of h', while a valve lift four times as great is obtained with a double speed of rotation by means of which the central angle is doubled. Because of this a double-seated valve of 200 mm. (7.87 in.) diameter can be replaced by a disk valve 100 mm. (3.93 in.) in diameter, with a corresponding reduction of clearance space and cylinder condensation area.

The valve motion is regulated from a layshaft running at twice the speed of the engine shaft by means of a cam, of which the lift and lead are regulated by means of a shaft governor, Fig. 3. The motion of the eccentric is transmitted to the disk valve by means of an intermediate lever and an angular lever located in the casing. The intermediate lever is made up in the form of an eccentric ring set on a rigid eccentric disk running at the same speed as the main engine shaft. The arrangement is such that when the main eccentric takes the position corresponding to the maximum valve lift the auxiliary eccentric on the second lay shaft is in the opposite extreme position, thus producing an increased valve lift. When the main eccentric occupies the next similar position, the auxiliary eccentric reaches the opposite location so that the actions of the two eccentrics have to be subtracted from each other. The resultant valve motions are shown again in Fig. 4, by means of the Zeuner polar diagram, which emphasizes the extent of the valve opening resulting from the fact that the valve shaft runs at twice the speed of the main engine, and also shows the absence of all necessary motion of the valve in the opposite position. The linear lead remains the same. As a result of this arrangement it becomes possible to use small valves with a total clearance in the cylinder of between ¾ and 1 per cent. and with an extremely small area of cylinder condensation surfaces. If it be assumed that these condensation surfaces are ideally small, that is, equal to twice the cross-section of the cylinder, it would appear that the additional cylinder condensation surface entailed by the use of the small high-lift nozzle-disk valve is only from 3 to 5 per cent. thereof. It is claimed that this arrangement affects the reduction of cylinder condensation area in a most favorable manner, which is generally low in straight-flow steam engines. As regards this latter, reference is made to tests carried out on a straight-flow cylinder by Professor Nagel, at the Dresden Polytechnic Institute. (The temperature diagram of these tests is reproduced in Fig. 5.) In that case only the cylinder head was provided with a jacket and the engine was operated with an extremely good vacuum. Notwithstanding this fact, during the exhaust stroke the temperature, as determined by a thermometer in the head, did not fall below 100 deg. Cent. Because of the extensive temperature drop during the exhaust and because of the appearance of a very considerable percentage of moisture in the steam (as high as 20 per cent), the heat of the steam in the head was caused to flow with great energy into the rest of the steam still present in the cylinder. Of this heat practically none is lost in the exhaust. The piston on its return stroke collects this overflow of heat by the compression of the remainder of steam to something like 2.5 to 3 atmos., corresponding to a clearance of about 3.3 per cent. The next compression occurs practically along the saturation adiabatic curve, which is joined at an angle by the superheat adiabatic curve and gives the startlingly high compression and temperature of 510 deg. Cent. At the end of the admission the superheat expansion adiabatic curve joins on, and then abruptly the saturation adiabatic curve. The latter, in its last stages, is raised by the setting up of the flow of heat referred to above, until the exhaust again causes temperature drop, which

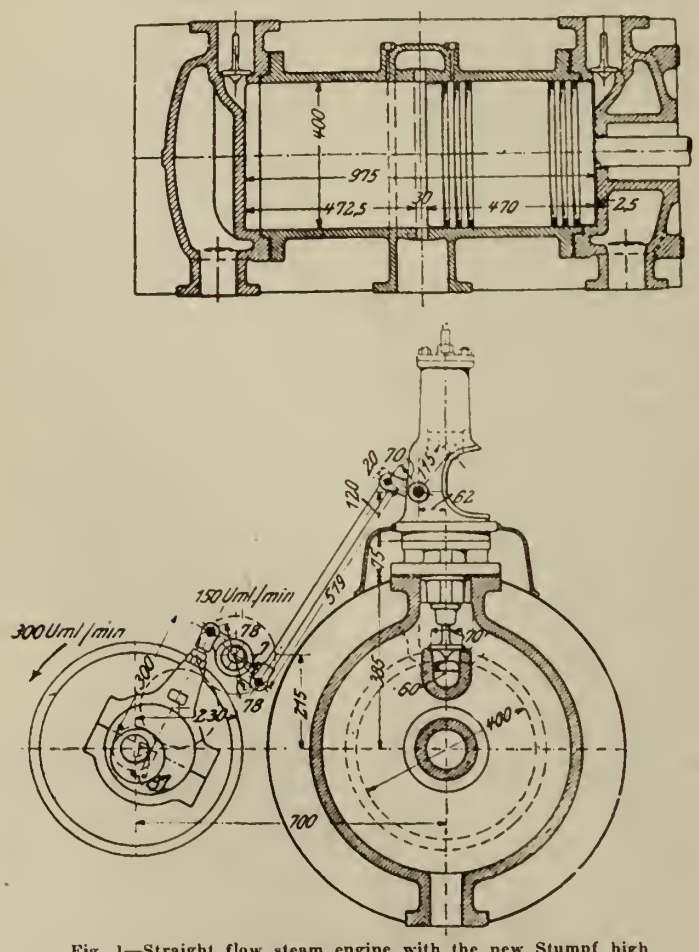
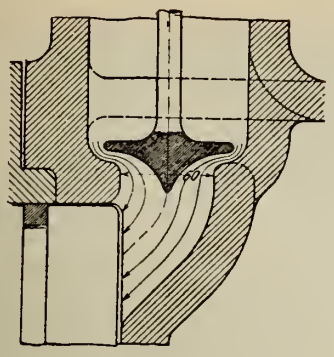
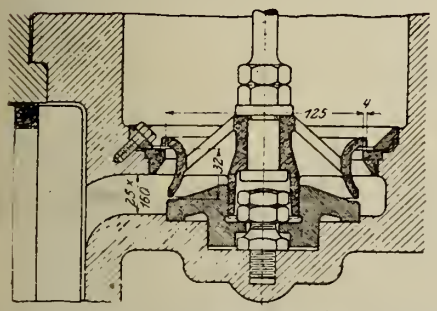


Fig. 1—Straight flow steam engine with the new Stumpf high lift nozzle disc valve.

Fig. 3—Valve gear drive.





Comparison of two kinds of engine valves with same area of steam passage. Above, high-lift nozzle disc valve.—Below, double seated valve.

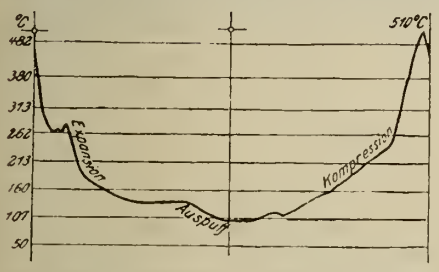


Fig. 5 Temperature Diagram
(*Auspuff* = exhaust)

is, however, immediately opposed by the flow of heat from the cylinder-head steam.

However, when, by the use of the high-lift nozzle-disk valve the clearance is reduced from 3.3 per cent to something between ¾ and 1 per cent., the compression end pressure is raised correspondingly, resulting in a rise of compression and temperature of between 900 and 1000 deg. cent. In this connection Professor Nagel has established the surprising fact that in the same manner a final compression temperature with saturated steam is obtained 100 deg. Cent higher than with superheated steam, which is probably attributable to the higher heat conductivity of saturated steam.

If, however, these favorable heat conditions are combined with small cylinder condensation surfaces as becomes possible with the new high-lift nozzle-disk valve it may be ultimately possible to do away with cylinder condensation entirely.

The upper part of Fig. 6 shows the new high-lift nozzle-disk valve operated by a lay shaft running at twice the speed of the main shaft, as compared with the double-seated valve of standard design below it, and also their relative dimensions. It is also claimed that

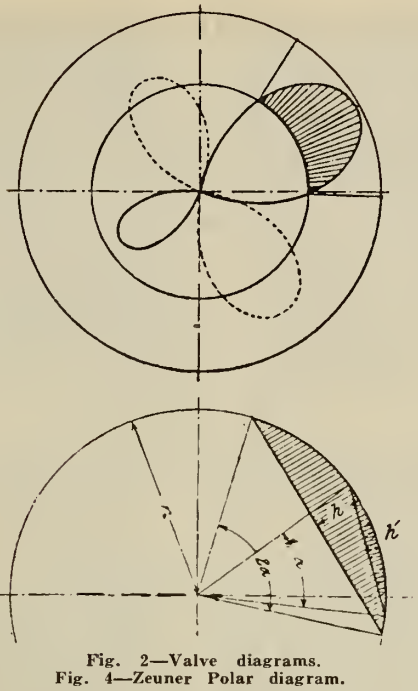


Fig. 2—Valve diagrams.
Fig. 4—Zeuner Polar diagram.

the new valve is considerably simpler and cheaper both in manufacture and in installation. (Zeitschrift des Vereines Deutcher Ingenieure.)

A Few Days Ago a generator under test at the Canadian General Electric Co., Peterboro, Ont., exploded, causing considerable damage, and one death. Since that time the matter has been gone into carefully and an official estimate places the damage at about $150,000. The generator, valued at over $50,0000, is wrecked, a number of other generators being built in its vicinity are seriously damaged, and several machines and the instruments and records of the test department are destroyed. The generator, engineers say, was being operated at 100 per cent. over speed, about 1,000 revolutions a minute, when the accident occurred. This means that a given point on the rotor was travelling at the rate of about four miles a minute.

Chatham, Ont.—Fuel oil is now being used with success at the Corhill Bros. brick plant. The new burner used is the result of seven year's experimenting and a combination of steam and fuel oil is employed. The bricks. produced are said to be of a more uniform quality.

The Toronto, Ontario, Canada, office of the Independent Pneumatic Tool Company has been removed from 32 Front Street West, to No. 163 Dufferin Street, Toronto. This new location will give the Independent Pneumatic Tool Company larger space and increased facilities for carrying a complete stock of Thor Pneumatic Tools, Electric Tools, Spare Parts and Accessories. The Toronto Office will remain in charge of Mr. William McCrae.

BOOK REVIEW

We have received from the Van Norstrand Company of New York, three books dealing with heat and temperature. The author is R. Royds, M. Sc., A. M. I. Mech., who is head of the motive power Engineering Department in the Dundee (Scotland) Technical College. The books are entitled, "Heat Transmission Boiler Condensers, and Evaporators." "The Measurement of Steady and Fluctuating Temperatures," and "Heat Transmission by Radiation, Conduction and Convection."

The first book is divided into three departments, boilers, condensers, and evaporators. The first part goes very thoroughly into the heat transmission from furnace to water in the boiler, and gives the results of tests, and a very thoroughly analysis of all the conditions relating thereto. This chapter contains 100 pages, and is clearly illustrated by charts and diagrams. The second division of the book goes into the question of condensing steam, and contains a very thorough exposition of the theory and practice of condensing, and all the latest knowledge and experiments along this line of study. The chapter on evaporating should be of special value to those interested in sugar making and allied industries. There are several pages of tables and data.

The work on "Heat Transmission by Radiation," etc., takes up all the work that has been done along these lines by various authorities and the results of experiments made by the author himself. This work leads up to the one just mentioned, and the two together form a very complete and valuable compendium of the subject of heat transmission. The various diagrams and charts are very clear, and the calculations have been worked out in a way that makes them very easily followed by the reader.

The third book is a very complete review of the various instruments in use for measuring temperature, and is very profusely illustrated. To the large number of people who invariably think of a thermometer as a glass tube filled with mercury this little book would open up a world of wonder, while to the practical engineer who has a wider knowledge of heat measuring instruments than the layman, the book will be found very valuable. The three together comprise a real little library on a highly important subject. They should be especially useful as text books in technical colleges and universities as well as to the practical and consulting engineering profession. The price of three volumes is $13.50, or $4 for part 1 and $4.50 each for the volumes on heat transmssion.

ANNOUNCEMENT

Peacock Bros., Ltd., Montreal, have been appointed district representatives for the sale of Cope's Pump Governors, in the Province of Quebec.

The Power Plant of the Eastern Car Company

In this Article, our Maritime Provinces Representative Has Described Another Large Power Plant in Nova Scotia. This Company Operates One of the Leading Industries in the Maritime Provinces, and the Power Plant is an Interesting One

By J. A. McGillivray

THE PLANT of the Eastern Car Company, situated on the East River of Pictou County, marks one of the milestones of industrial development in the Maritime Provinces, in recent years. Built entirely of steel and concrete, and equipped with the most up-to-date machinery for freight car building, having a rated capacity of 25 cars per day, and a record to its credit of 35 cars per day (140 per cent.,) its activities have not been confined entirely to freight car building, but it has undertaken and profitably completed such work as motor trucks, snow ploughs, locomotive repairs, steel pit boxes, munition making and steel pressing for steel ship building.

There is in connection with the car plant a wheel foundry, operated at present under lease by the Dominion Wheel Foundry Co., having a capacity of 500 car wheels per day, as well as other varieties of heavy castings.

The plant is a subsidiary of the Nova Scotia Steel Company, now forming one of the extensive holdings of the British Empire Steel Company.

The situation of the plant is ideal, being located on tide water. The lumber required for manufacturing purposes can be landed in its own yards from the parent company's own ships. To facilitate this the East River was dredged from Pictou Landing to Trenton to accommodate ships of large tonnage. A system of locks were built just below the company's holdings, and a natural basin at the site of the company's holdings forms an ideal anchorage. The East River waters are maintained at high tide level by the lock gates. The steel for manufacturing purposes is supplied mainly from the parent company's steel mills, whose yards adjoin those of the car plant. The coal and coke is supplied from the company's own mines, two miles distant, so it may truthfully be stated that the car plant is ideally situated. Not only this, but the parent company's shipyard is located in the yards of the Car Company, who supply light and power as well as pressed steel and woodwork to that industry.

The shipyards build steel ships of from 3,000 to 5,000 tons capacity, and have at present on the ways an almost completed steel yacht that represents the best and most modern in ship construction in America.

The most interesting part of this company's equipment to engineers is the power plant, which supplies light and power to the car plant, shipyards and steel mills of the parent company.

The central power plant of 2,400 B. H.P. tabulated consists of the following equipment, which will be described in order given.

The Central Power Plant —Fuel Handling

1 track hopper, capacity 40 tons.

1 coal breaker, (Brown Mach. Co.) 40 tons per hour.

1 Gravity bucket conveyor (Brown Mach. Co.) 40 tons per hour.

1 40 H.P. General Electric three-phase, 60 cycle, A.C. motor, connected to coal breaker and bucket loader.

1 15 H.P. General Electric three-phase, 60 cycle A.C. motor, driving gravity bucket conveyor.

1 400 ton concrete lined steel bunker for coal storage, over boilers.

1 Sturtevant Blower System for delivering shavings, sawdust and wood refuse to boilers.

1 concrete storage vault for storage of shavings; capacity, 18,000 cubic feet.

Boilers

Boiler room, 110'x40'x46' high to eaves.

4 Edge Moore "all steel" water tube boilers, having a combined heating surface of 24,000 square feet, and equipped with Foster super-heaters having a capacity of 125 degrees superheat.

Stokers

4 Green chain grate stokers, 110 square feet surface each.

Breeching

1 steel breeching, extending over the boiler and terminating in a concrete chimney.

Chimney

1 concrete chimney, (Weber), 175 ft. above the grates, 8 feet diameter.

Main Header

1 16 inch ex. h. steel, 70 feet long, anchored at centre with outlets at each end and separate branches to turbines.

Feed Pumps

2 Standard Weir pumps, size 14 in. x 10 in. x 24 in. stroke, capacity 88,000 lbs. per hour, at 70 per cent. efficiency, against 450 feet head.

1 4-in. Venture Meter, (Builders' Iron Foundry Co.)

1 5,000-H.P. Cochrane open feed water heater.

The boilers are equipped with Reliance high and low water alarms inside of Reliance Standard Safety water column. Ashton spring pop safety valves, 2½ in. Pemburthy Injectors, Locke damper regulators, Ellison differential draft gauges, standard steam gauges, steam pressure and steam temperature recording gauges. Feed water temperature recording gauges, Crane non-return valves on both main and auxiliary steam headers. Diamond soot blowers are installed. They are of the six element type with the latest standard jets.

Turbine and Engine Room

110 feet by 60 feet by 25 feet at eaves. Separated from boiler room by concrete wall with standard safety fire doors, contains the following:

Turbine Floor

Cond. Turbo Gen. No. 1, 750 K.W. 3600 R.P.M., 3 phase, 60 cycle, 600 V-903 amps, General Electric, Lynn, Mass.

No. 2. 750 K.W. Turbo Gen. 3600 R.P.M., 3 phase, 60 cycle, 600 V-903, A. General Electric Co., Schnectady, N.Y.

No. 3. Non-Cond. Turbo Gen. 750 K. W., 3600 R.P.M., 3 phase, 60 cycle, 600 V-903 A. Westinghouse Mfg. Co., Pittsburgh.

No. 4. Non-Cond. Turbo Gen., 125 K. V.A., 1800 R.P.M., 3 phase, 60 cycle, 600 V-Terry Steam Turbine driven. Crocker Wheeler Generator with direct connected exc.

Separate Exciters

No. 1. 35 K.W., 1200 R.P.M., 120 V Motor Gen. Set.

No. 2. 25 K.W., 3600 R.P.M., 120 V. Curtis Steam Turbo driven.

No. 5. Motor Generator Set, 900 R.P. M., 250 V., 800 A., comp. wound, driven by 400 K.W. synchronous motor direct connected. General Electric Co., Peterborough, Ont.

Switch Board

14 panel. G. E. standard, 600 V. S. B. as follows:

4. A. C. Generator Panels, equipped with volometer, ampmeters, wattmeters, frequency and P. F. meters.

1. D. C. Gen. panel, 1 exciter panel.

1 motor generator panel. 1 A.C. voltage regulator panel.

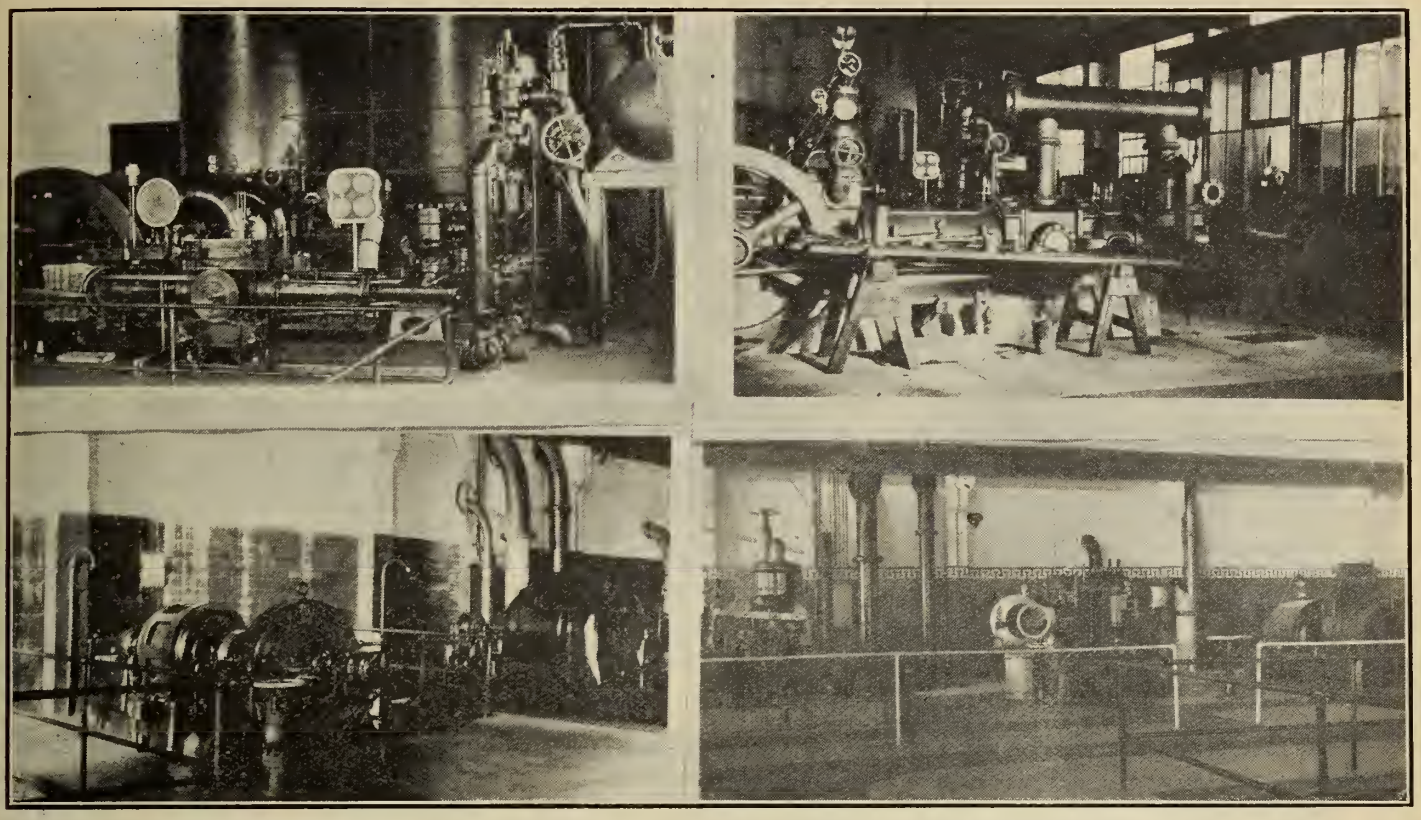
1 lighting trasformer panel.

9 Power feeder panels.

No. 1, air compressor, (Can. Rand.) 3000 cubic feet capacity.

No. 2 air compressor, (Can. Rand.) 1000 cubic feet capacity.

No. 1 hydraulic pump, capacity 400 gallons per minute, against 3000 feet head.



(1) 3 crank hydraulic pump.
(2) 1,000 C. F. Rand Compressor.
(3) Terry Turbine and Crocker Wheeler Generator.
(4) The Turbine Floor.

1 15-ton electric overhead crane (Shaw.)

In Basement

1 Darling Bros. Simplex double-acting vacuum and two Martin Duplex double-acting return vacuum pumps, connected to Webster Return Vacuum Heating System.

1 10x20x10 inch Blake Knowles dry vacuum pump.

1 8x12x10 inch Blake Knowles dry vacuum pump.

1 2½ inch Terry steam turbo driven Worthington hot-well pump.

1 2 inch Terry steam turbo driven Worthington hot-well pump.

1 Wheeler surface condenser, 3000 square feet, C.S.

1 Wheeler surface condenser 1600 square feet, C.S.

2 165 ton R. D. Wood accumulators for hydraulic.

1 24 inch Crane oil separator.

1 30 gallon oil filter.

At Tide Water Pump House

Pump No. 1. Circulating pump, size 8 inch., Vert. turbo pump, 1700 R.P.M., (Worthington) direct connected to G.E. 50 h.p. A.C. motor.

Pump No. 2.. Circulating pump, size 6 inch, vert. turbo pump, 1700 R.P.M., (Worthington) direct connected to G. E. 25 h.p. A. C. motor.

Pump No. 3. 1 Vert. 2½ inch Worthington turbo pump, direct connected to 10 h.p. G. E. motor, used for pumping out the pump pit.

The Boilers

The boilers burn both coal and shavings, the coal being fed to the grates in the ordinary way. The shavings being introduced through openings in the top of the Dutch ovens, these openings are admittedly a source of excess air and care is taken to seal them when burning coal alone.

The furnaces as originally constructed were the Standard Green type for burning bituminous slack coal, but in order to get good rating when using a very low grade of fuel it was deemed advisable to change the ignition arches to what is known as the sealflex arch, patented by the Green Engineering Company. This change was made when the stokers were being repaired.

During tests made with low grade fuel the best results were obtained with a grate speed of 4 in. per min. and a fuel bed of 4½ inches in thickness. At higher speeds the fire would carry away from the grate, while if the fuel bed was reduced the fire burned off short and if thickened over 4 in. green coal carried over. So after many experiments a standard rule was adopted, based on the results of these experiments. A variety of tests were conducted with a view to getting the best grate speed and fuel bed thickness to operate at approximately 150 per cent. capacity. The most satisfactory of these results are given here.

The boilers are operated at approximately 150 per cent. of rating, and are 600 h.p. commercial rating. They are of the straight tube type. The tubes have an incline to the rear, and being 15 tubes high and 20 wide, with 4 inch tubes 18 feet long, and are vertically baffled. The water legs are forged steel.

The drums are 36 inch diameter, 3 drums to a unit and are bolted to the water legs instead of riveted. A copper grumet on the bolt, which is tapered, makes the job tight. The working pressure is 200 lbs per square inch, the steam being superheated to 125 degrees Fah. All the steam generated passes through the superheater, there is no mixing of steam and no provision made for by passing the superheater, so if one of the

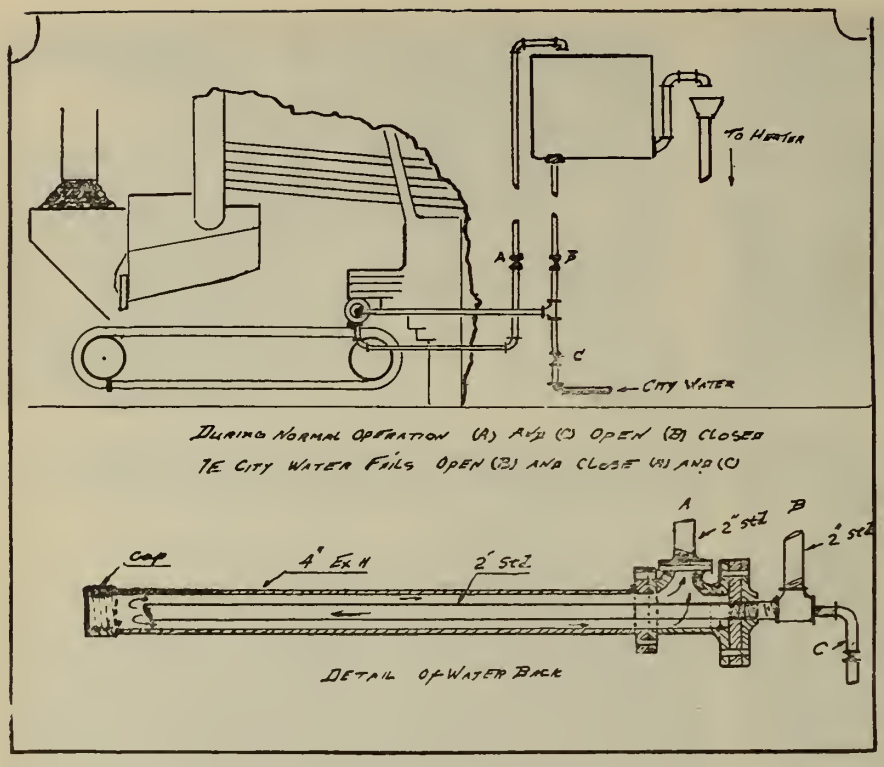
CAPACITY TEST WITH GREEN CHAIN GRATE STOKER. EQUIPPED WITH SEALFLEX ARCH UNDER 600 H. P. EDGE MOOR W. T. BOILER.

	DRAFT Over Fire	Last Pass	Flue Gas. Temp. Deg. F.	CO_2	Thickness of Fire	Speed of Grate per min.	Horse Power	Per cent. of rating developed.
	.343	.77	386	9.91	5.0″	3.8″	938.	156.4
	.32	.80	410	11.02	4.5″	4.2″	837.	139.5
	.32	.80	433	12.10	4.5″	4.0″	908.	151.3
	.512	.87	412	10.53	4.5″	4.0″	1025.	170.8
	.47	.86	431	11.33	4.5″	4.0″	1017.	169.6
	.47	.81	441	11.87	4.5″	4.0″	955.	159.1
	.49	.84	425	12.76	4.5″	4.0″	939.	156.5
AVER.	.417	.82	419	11.46	4.57″	4.19″	946.	157.6

ANALYSIS OF COAL.—

Natural Draft ½ inch over fire.

Moisture	1.25%
Vol. Matter	34.25%
Ash	16.65%
Fix. Car.	59.52%
Sul.	7.37%



Arrangement of water back.

elements gives out the boiler must be closed down. However, this has been known to occur but once since the installation of the plant, and was due primarily to insufficient expanding of the superheater tubes into their header. After the superheater tubes were properly rolled there was no further trouble from that source.

The bridgewalls are supported by a water back made of 1 inch Ex. heavy pipe as shown in sketch. In some installation of the type of boiler the water cask is connected to the water space of the boiler, and thus becomes part of the heating surface. This type is called the high pressure water back.

The grate surface is 110 square feet.

making the ratio $\frac{\text{H. S.}}{\text{G. S}} = 54..54$. The

average efficiency of operation for the boiler, furnace and grate is normally 70 per cent,, this varies, of course, up and down with the conditions, being about 65 per cent. on the night load and 75 per cent on the day load.

The boilers are connected to the main header by long crane bends. The connections are 8 inch, connecting into a 16 inch steel header, which is anchored at the centre and free to expand both ways. The steam header is fitted with valves so that any section can be cut out without interruption to service, and the main and auxiliary headers are so cross-connected that steam can be had from either for any machine or any auxiliary so long as there is one boiler under steam. The feed lines are also so connected that the pumps can feed the boilers through the injector lines, and vice versa, and should the city water pressure fail for any reason, the feed pumps or injectors can instantly be connected to the company's 300,000 gallon reservoir.

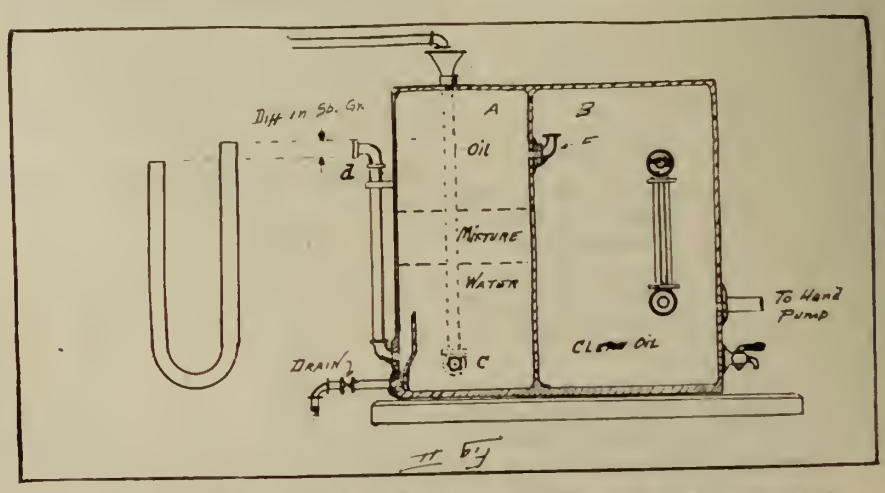
The feed water is supplied to the boilers at a temperature of 200 degrees Fah. to 210 degrees Fah. The overflow from the water backs at 90 degrees and the cooling water from the compressors at 90 degrees supply the feed heater with make-up water. The heater also receives the returns from the vacuum system as well as the condensate from the turbines.

The installation of steam soot blowers marked a vast improvement over the hand method both as a labor saver and an efficient cleaner. It was found that the hand method resulted invariably in banking the soot at the far side of the tubes instead of clearing it out entirely, whereas the mechanical blowers clean the soot off all the tubes almost 100 per cent. clean, except the two bottom rows, where the deposit (commonly referred to as birdsnesting) must be knocked off from time to time with a bar. The fireman showed me a nifty rig he fitted up for the purpose and it certainly did have some merit. It was made of 1 inch pipe reduced about the middle of its length to ¾ inch, and at three quarters of its length to ⅜ inch, with the end turned up. This he would connect to the compressed air hose and work it from the inspection door at the side, blowing up between the bottom rows of tubes and at the same time poking the nozzle into the deposits and dislodging them. Of course at week ends the tubes would be scraped clean.

This device had another use that should be mentioned. The fireman used to blow the accumulation of soot that forms on the bridgewall off every night and always had a clean bridgewall instead of a big sloping bank that we usually see, reaching clear to the bottom row of tubes, with the result that when it comes to be cleaned part of the bridgewall is liable to come with it.

The Engine Room

No. 1 Turbine is a 730 K.W. Curtis, built at Lynn, Mass., 3,600 R.P.M., of the Bleeder type. The bleeder is used in winter months for steam extracting from between the stages for shop heating. When the turbine is fully loaded 35,000 lbs. of steam per hour can be extracted from the first stage at a pressure of 5 lbs. gauge. The bleeder line (12 inch), is connected into the 24 inch heating main, with a suitable check valve between the turbine and the H.M., located in the 12 inch bleeder line, close to the turbine, at a predetermined pressure in the H.M., which may be anywhere between 0 and 5 lbs. The bleeder connection is automatically closed off and where the pressure falls off the bleeder is again automatically put into service. The turbine is a two-stage, using steam at 175 lbs. gauge superheated 100 degrees Fah. at the turbine inlet. The steam main is 5 inch, the water rate of the machine is guaranteed at 16 lbs per K.W.H. (When the pressure in the condenser is 2 lbs. absolute), the machine is fully loaded. Normally the vacuum is 29 inches or ½ lb. abs. in the condenser.



Description of Operation—Oil and water is piped to funnel and enters compartment (A) at bottom and displaces equal volume. Oil flows at (E) and water at (D), the mixture separating at (C), the oil floating to the top. The U tube shown at left illustrates the principle of operation.

The turbine and generator are coupled together by a solid coupling. There being three bearings, the packing on the shaft is of the labyrinth type steam sealed at a pressure of 10 lbs per square inch. The oil is supplied under pressure of 12 lbs per square inch by a gear pump driven from the main shaft. The cooling is accomplished by circulating water through a coil laid in the bearing linings. The oil reservoir contains 30 gals. The normal temperature of the oil is 145 degrees Fah. to 150 degrees.

The turbine is connected to the condenser by a corrugated copper expansion joint 30 inches in diameter. The condenser has a cooling surface of 1600 square feet, (a little over 2 square feet per K. W..H.) The condensate is discharged to the feedwater heater by a Terry steam turbine driven Worthington pump, size 2 inch discharge. The air and vapor is drawn from the condenser by a 10 inch by 12 inch by 10 inch Blake-Knowles dry vacuum pump, (speed 100 R.P.M.)

The generator is 3 phase, 60 cycles, 3600 R.P.M., 600 V-903 amps, 80 P.F. with a separate exciter. The cooling air for all the generators is conducted from the roof of the building through a duct having an area of 20 square feet. The air being forced through the ventilating spaces of the machines by fans mounted on the revolving field, and being discharged through a separate duct into the basement.

Turbo Gen. No. 2

This turbine is a mixed pressure Curtis type, which can be operated either as a straight high pressure condensing unit, low pressure cond. or mixed pressure.

There are two separate steam lines to the machine, One is a 6 inch high pressure (175 lbs gauge) the other a low pressure, about (15 lbs abs.) The capacity of the machine is 750 K.W. and speed 3600 R.P.M. built at Schenectady, N.Y., by the Gen. Eelect. Co.

This machine will develop its rated load (750) K. W. on low pressure steam, 15 lbs., at the throttle and a condenser pressure of 2 lbs. abs. with a steam cons. of 34 lbs, per K. W. H. As there is available in summer months quite a large quantity of exhaust steam over and above the feed heater requirements, the mixed pressure machine is operated on mixed pressure. The governor operates the valve gear by a cam that causes the L.P. admission valve to open full before the H. P. valve opens. Thus the full benefit of the L.P. steam is realized before any H.P. steam is admitted. If there is sufficient L.P. steam to carry the load the H. P. valves will not be opened. But if the supply of L. P. falls short of the requirements, the turbine governor continues to drop until the live steam is admitted to the turbine.

So that the vacuum won't reach back into the exhaust lines when the L. P. steam falls off, there is a Cochran multiflow valve placed in the line close to the turbine, which closes off communication between the low pressure nozzles and the exhaust lines. This prevents an inrush of air to the condenser impairing the vacuum and also prevents oil being sucked into the condenser and consequent polution of the feed water.

The generator, condenser and auxiliaries are practically the same as No. 1 machine, except that they are larger on account of the machine being run as a low or mixed pressure unit. The dry vac. pump is 10x20x10 inches, speed is 100 R.P.M. The wet pump is 2½ discharge and the condenser 3000 square feet, cooling surface, or 4 square feet per K.W.

Turbo Gen. No. 3

A H.P. non-cond. Westinghouse 750 K.W., 3600 R.P.M., connected to 750 K.W. generator, 3 phase, 60 cycle, 600 V-903 amps., with direct connected exciter.

This turbine is run non-condensing in the winter months. The exhaust steam being used for shop heating and kiln drying of lumber.

Turbo No. 4

A 125 K.V.A. non-condenser Terry steam turbine connected to a Crocker-Wheeler generator, 3 phase, 60 cycle, 1800 R.P.M., 600 V, is used for a standby set for lighting and small loads at week-ends. This machine can be started up and put on the S. B. in an emergency in 30 seconds. The machine is always kept warm and in readiness. It is particularly useful for getting the motor driven auxiliaries of the main units in operation when starting the plant so that the main units may be started condensing.

There are 3 turbo pumps at the tide water pump station. They are about an eighth of a mile distant from the central plant and can be started or stopped by remote control switch and all those pumps can be connected into the 18 inch circulating water main to the condensers if needed.

Power is supplied to the steel mills of the Nova Scotia Steel Company at 2100 volts and to the Nova Scotia Steel Shipyards at 600 volts (A.C.) and 250 volts (D.C.) also to the wheel foundry at 600 volts (A.C.) and 250 volts (D.C.) the balance being used in the car plant. The power house lighting system is so arranged that should anything occur at night to interrupt the main lighting system, one of the separate exciters, being steam driven, can be pressed into service for lighting the power house and boiler room and also supply power for the overhead crane.

Air Compressors

No. 1 compressor—Can. Rand compound non-condenser steam Corliss driven, capacity 3000 cubic feet per minute, at 90 R.P.M.

Steam cylinders 17"/34"x36".

Air cylinders 34"/20"x36".

No. 2 compressor—Can. Rand "Simple" non-condensor steam tandem compound air straight line type. Capacity 1000 cubic feet per minute. Equipped with Myer cut off size.

Steam cylinders 20"x12" stroke.

Air cylinders 20"/12"x12" stroke.

The steam is supplied to this engine through a reducing valve at a pressure of 125 lbs per square inch.

Hydraulic pump. Non-condenser Laidlaw, Dun & Gordon (Cincinnati, Ohio) now known as the International Steam Pump Company. This pump has a capacity of 400 gallons per minute against a 3000 feet head. The steam pressure is 175 lbs. at the throttle. This is a three-crank high duty engine-driven hyd. pump, having steam cylinders 19/30/30 by 24 inch stroke, and water pistons (outside packed) size 5 inch, the common stroke being 24 inch.

The engine is a Corliss, having single eccentrics with releasing gear on the H.P. cyl. and an adjustable knockoff cam. There is also a flyball governor which arrangement rather puzzles the beholder at first. However the flyball governor is a necessary provision when the nature of the work is understood.

In order to maintain a constant pressure on the hydraulic system, there is an accumulator with a 16 inch piston or ram floating on the line, weighted to 150 tons. At 1500 lbs. per square inch the piston begins to raise the weight, since the area of the 16 inch piston (201 square inches) times 1500 = 300,000 lbs. = 150 tons. When the piston reaches the limit of its travel (18 feet) it leaves a storage space which is equivalent to the piston displacement, equal to

$$\frac{201 \times 18 \times 12}{1728} = 25.12 \text{ cubic feet.}$$

When the accumulator weight reaches nearly the top of its travel it engages an arm to which is connected a cable passing over pulleys to the chrometer valve on the steam main to the high pressure cylinder. Any further travel must, therefore, close the pump down. When the accumulator ram falls again, due to withdrawal of water by the hydraulic presses, the chrometer valve is again opened and the pump starts up.

Oil and Water Separator

All the oil used on the reciprocating engines is collected in a home-made separator in the engine room basement. The operation of the separator is automatic and for a home made affair is worthy of description. The whole thing is made of galvanized iron and a few bits of pipe. The tank is divided into two compartments as shown in sketch. The oil, after being used in the engines, flows by gravity through a pipe and is delivered in compartment (A). The oil and water separating at (C) the oil rises to the top and the water is displaced through (D). At the same time there will be a displacement of oil at (E) into compartment (B), from where it is pumped by a hand pump to a 30 gallon Cross oil filter. The quality of the separated oil depends upon the difference in height of points (D) and (E). The best adjustment can be found by trial. It is easy to adjust if elbow (E)

(Continued on page 36)

Efficient Operation of Oil Burning Plants

A Discussion of the Plant—Characteristic Diagram, with Particulars Regarding its Use in the Establishment of a Standard of Performance and in Increasing Plant Efficiency

By C. H. Delaney*

DURING the past ten years there has been a remarkable increase in the efficiency of steam plants, both oil-burning and coal-burning. Ten years ago there were many plants operating reciprocating engines, in which the maximum economy obtained was not over 150 kw-hr. per bbl. of oil.

With the high-pressure steam-turbine plants of the present day a record of 330 kw-hr. per bbl. has been made. This increase in efficiency has been brought about by introducing more efficient machinery and increasing the range of steam pressure in the prime mover. The introduction of the steam turbine to replace the reciprocating engine effected a remarkable saving in the quantity of fuel required. Moreover the steam turbine caused a saving in operation due to the fact that its operation does not depend on the personal element in the plant.

In the old reciprocating engines there were many adjustments to be made by the engineer in charge, and the economy obtained depended very largely on the skill of the operating engineer and the care with which he made the various adjustments. With the steam turbine, however, there is nothing that the operator can do to improve the efficiency after the machine is once installed and placed in good operating condition. While this is true as regards the prime mover, it is not true in regard to many other features of the power plant. In the boiler room particularly there are many points where the operating engineer can effect a saving if he carefully studies the situation and pays attention to the small details of operation.

In condensers and vacuum pumps also a great saving can be made if proper attention is paid to maintaining a high vacuum. There is still, therefore, a large field for the operating engineer in improving the economical operation of the plant, and the question of operating efficiency is consequently one worthy of very careful study.

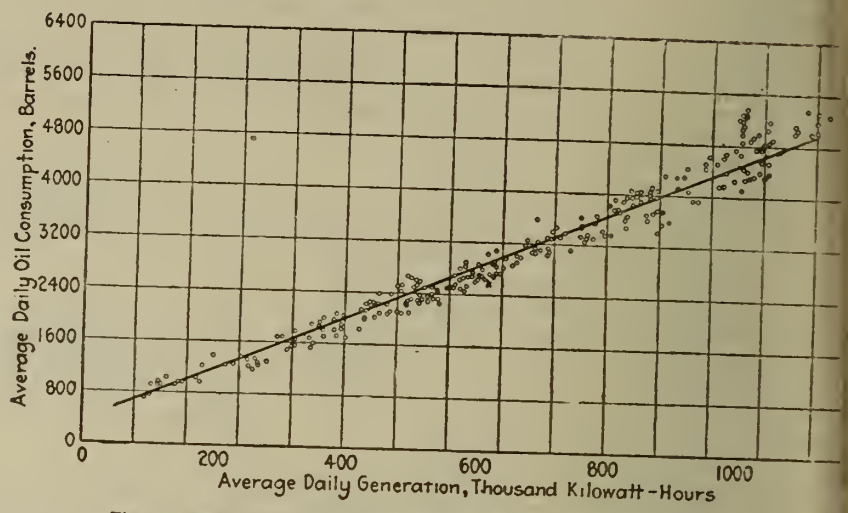


Fig. 1—Plant characteristic diagram for a San Francisco station.

Many tests have been published showing very high efficiency of boilers where fired with fuel oil, efficiencies as high as 80 and 82 per cent being not uncommon in test reports. It is very rare, however, that any such efficiencies are obtained in the regular operation of power plants. In order to maintain high efficiency in regular operation of a plant, the first requisite is some means of comparing one day's operation with another. In oil-burning electric power plants it is customary to report the economical operation of the plant in terms of kilowatt-hours generated per barrel of oil. This is an excellent method of comparing one day's operation with another provided there is steady load on the plant and conditions remain the same from day to day. With a variable load, however, such as occurs in an ordinary central-station plant, it is always found that the economy is much better at periods of light load. Thus it is possible with a fairly heavy load on the plant to secure from 220 to 230 kw-hr. per bbl. of oil without difficulty, whereas with the same plant operating at a light load it may be difficult to secure more than 150 kw-hr. per bbl. of oil.

When the good results are obtained with the heavy load, the operating men pat themselves on the back and consider that they are doing fine, because results are better than the average. On the days of light load when the results are poor, they do not worry but say, "What's the use, you can't expect good results with such a light load." Thus in neither case is there any incentive to improve the economical operation of the station. Another reason for more or less lax methods, so far as efficiency is concerned, is the fact that efficiency must always be secondary to continuity of service. The men at the plant know that any interruption to service will be a matter of close investigation on the part of the management, and they devote all their energies to maintaining the plant in operation and keeping the lights burning. For instance, if a fireman in endeavoring to carefully adj

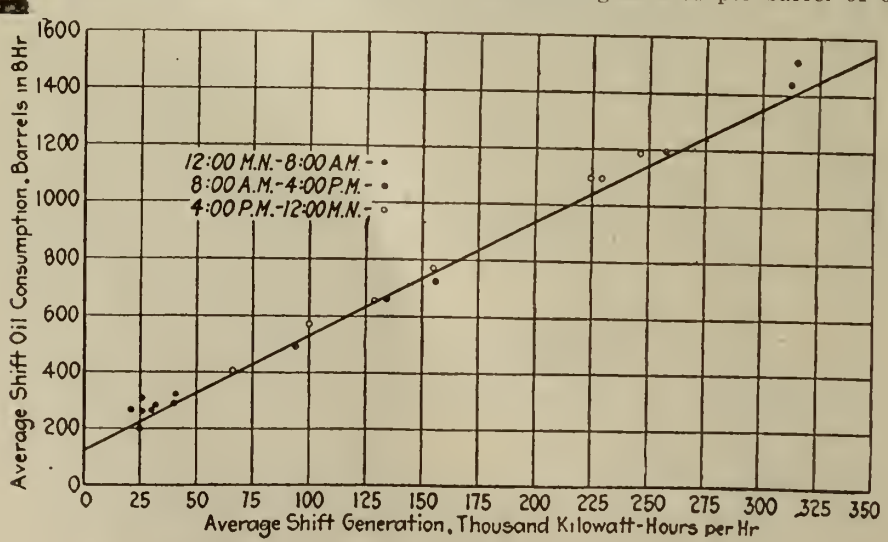


Fig. 2—Plant characteristic diagram with scale altered to show results obtained on an 8 hour shift.

1 Pacific Gas & Electric Co. Mem. Am. M. E.

Paper presented at a joint meeting of the San Francisco Sections of The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. March 17. Slightly abridged.

1 Trans. Am. Soc. M.E., vol. 38, p. 687.
2 Electrical Review (Chicago). Feb. 21. p. 311.

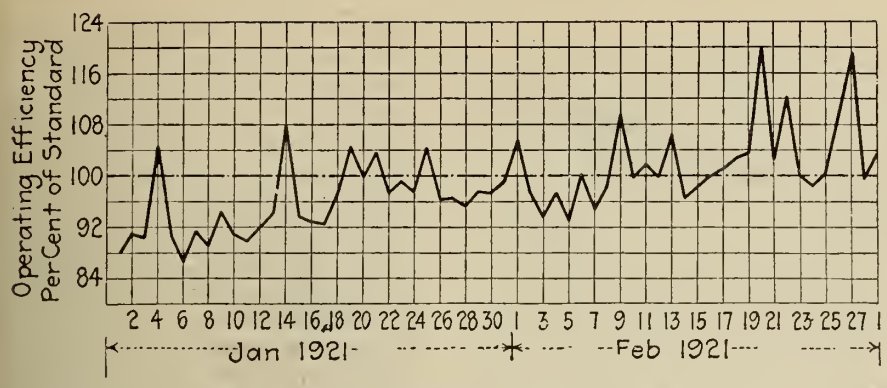


Fig. 3—Diagram of operating efficiency over two months period.

the air supply in boilers neglects to keep up the steam pressure, with the result that the turbine slows down and some of the load has to be dumped, he is sure to be called on for an explanation. If on the other hand he keeps up the steam pressure, but neglects to regulate the air in the proper proportion, there usually will be no complaint; and the boilers may be allowed to operate in this inefficient manner for a considerable length of time. The author is far from disputing the fact that continuity of service is a matter of prime importance, but he does wish to point out that efficiency is a close second. The problem before us, therefore, is to so interest the men who are operating the plants in the matter of efficiency that they will not neglect the various operating details that must have attention in order to secure good results.

In order to improve these conditions and to interest the men in the problem of efficiency, it is essential to devise some means of comparing the performance of a plant from day to day. For this purpose, the diagram here called the "plant characteristic diagram" has been plotted.

The Plant Characteristic Diagram for Comparing Performances from Day to Day

Fig. 1 shows such a diagram from one of the San Francisco stations. It consists merely in the plotting of the oil consumption against the kilowatt-hours generated. Each of the points in this diagram represents one full day's operation, and while the points as shown are more or less scattered, it is apparent that they form a well-defined line. It is thus possible to draw a straight line through the midst of these points in such a way that it will represent the average location of all the points in the diagram. There is nothing new in the use of a straight-line diagram, such as is presented. The line is similar to the Willans line for steam engines, where for throttling engines the total steam consumption plotted against the horsepower output is always found to be a straight line. A similar line for steam turbines is either straight, or very nearly so, depending on the design of the turbine. The use of the Willans line in the design of steam power plants was very ably described by R. J. S. Pigott in a paper read before the A. S. M. E. in 1916. [1]. The use of the plant characteristic diagram in improving the efficiency of steam plants has been described very fully by Robert H Parsons[2] of London; and in fact in describing this system as applying to oil-burning plants, the author is simply amplifying Mr. Parsons' paper on the subject.

Use of Diagram as a Standard for Guidance of Men in Operation of Plant

The diagonal line, having once been drawn through the points as described, may be used as a standard for the guidance of the men in future operation of the plant. Thus each day the kilowatt-hours generated and the oil burned the day before may be plotted on this diagram. If the point so plotted is found to fall below the diagonal line, it is evident that the results obtained are better than the standard. If the point falls above the line, too much oil has been used, and there is something wrong requiring a special investigation; and since the diagram takes in all loads from zero up to the full load on the plant, it is evident that it allows for the poor economy obtained at light loads. It is thus possible for the operating men to know immediately whether they are keeping up to the required standards of efficiency or running behind. They are therefore able to investigate causes of low efficiency immediately while all matters entering into the plant operation are fresh in their minds.

In adopting the standard it would be possible, instead of drawing a line through the average of the points, to draw a line through the best points, thus establishing a standard that would represent the best results obtainable from the plant. Again it would be possible to establish a standard by drawing a theoretical line below all the points, this line to be based on the steam consumption of the turbines and auxiliaries, as determined by tests, a boiler efficiency of, say, 80 per cent and the best possible vacuum. In other words, a line representing ideal conditions.

In adopting the average line as the standard it is felt that the men will have greater confidence in the method than if a theoretical line has been adopted. The average line is really a standard that has been established by men themselves. It is not an arbitrary ideal impossible to attain, but represents the average already attained. It should be as easy to improve on the results represented by the line as to fall below them.

If the men are successful in improving on the standard each day, it is obvious that the average for a given year will represent better efficiency than the average for the previous year. With all of the points falling below the line of the diagram, another line drawn through the average of these new points would also fall below the original line.

A diagram with the same diagonal line as determined by Fig. 1, but with the points omitted, may be used at the stations each day to plot the results of the day before.

Figure 2 shows a similar diagram, but with the scale altered so as to show the kilowatt-hours generated and the oil burned during a period of 8 hours instead of 24 hours. This diagram may be used by the different shifts in the station so that each shift can check up its own performance and compare it with the performance of the other shifts. A large diagram of this form is posted on the wall of the fire room, and different colored pins to represent the different shifts are inserted each day so that the diagram shows at all times which shift is running above the line and which shift is running below it. This system has a far-reaching effect in awakening interest in the men and leads to rivalry and competition so that they are extremely anxious to improve the efficiency, and the laxity which previously existed in regard to efficiency is disappearing. As the diagram allows for variations in load, it is possible to compare the day shift when the load is heavy with the early morning shift when there is very little load on the plant, thus making a fair comparison which was never possible with the old method of merely figuring the kilowatt-hours per barrel of oil.

There is one objection to the diagram —it does not indicate the order in which the records are plotted, and therefore does not show whether the results are improving as time goes on. In order to overcome this objection, and also to enable the operation of different plants to be compared with each other, the term "operating efficiency" has been introduced. Operating efficiency as used in this connection means the percentage of standard attained for the day's run. "Operating efficiency" is entirely distinct from "boiler efficiency" or "thermal efficiency" or "Rankine-cycle efficiency." All of these enter into the operation of the plant in determining the standard. Operating efficiency is merely a comparison of the results actually obtained with the standard.

The method of determining operating efficiency can best be shown by an example: During one eight-hour shift there were generated 313,000 kw-hr.

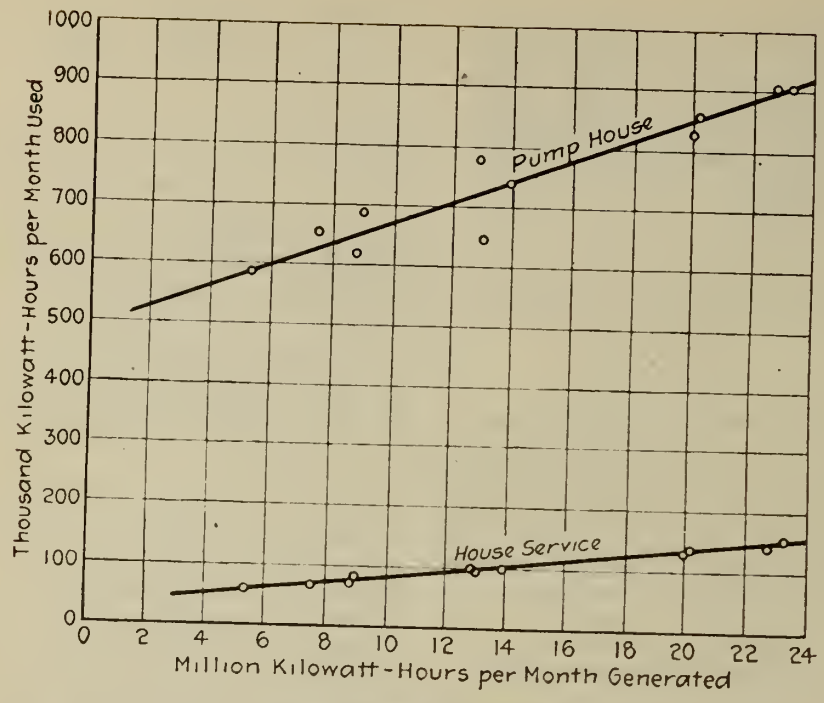


Fig. 4—Power used by electric auxiliaries, plotted against total generation.

and 1440 bbl. of oil were burned, representing an economy of 217 kw-hr. with standard efficiency, there would be burned only 1400 bbl. of oil, which would be equivalent to 224 kw-hr. per bbl., as against the actual result obtained of 217 kw-hr. per bbl. The operating efficiency is therefore 217 divided by 224 or 97 per cent. During another eight-hour shift, where there were only 25,000 kw-hr. generated, the oil burned was 200 bbl., equivalent to 125 kw-hr. per bbl. From the diagram it is found that for 25,000 kw-hr. with standard efficiency the oil burned would be 220 bbl., equivalent to 114 kw-hr. per bbl. The operating efficiency is therefore 125 divided by 114 or 110 per cent. It is thus seen that although in the second case there were only 125 kw-hr. per bbl. obtained, as against 217 in the first, operating efficiency was actually higher in the second case than in the first.

It is evident from the foregoing that if an operating efficiency of 100 per cent is obtained, it means that the economy of the plant is the same as the average of last year, since last year's records were used to establish the standard. If more than 100 per cent operating efficiency is obtained, the results are better than last year, and if less than 100 per cent is obtained, they are worse. It is obvious that this method of determining operating efficiency makes allowance for inefficient machinery, and it is just as easy to obtain 100 per cent operating efficiency in a plant having old-fashioned turbines of poor design as in a plant having the most up-to-date machines, for the standard is based on the actual records of the plant in question.

Fig. 3 shows the operating efficiency of one of the plants plotted for each day during the months of January and February. In this diagram the horizontal line at 100 per cent represents the standard efficiency and the zigzag line the actual operating efficiency obtained each day. The records show a gradual improvement in the operating efficiency during the period, which is a direct result of the attention to small details brought about by this method of checking up efficiency.

In addition to the use of the diagram for setting standards and creating interest among the men, a system of weekly and monthly reports and bulletins has been adopted. The weekly report, which is made out by the efficiency man at each station, gives the operating efficiency for each day and the average for the week, and in addition a brief statement of some of the more important instrument readings such as flue-gas analysis, vacuum, feedwater temperature, and steam consumption of turbines at different loads. The monthly report which is made out at the office and sent to each station includes a diagram of operating efficiency similar to Fig. 3 for all stations plotted on one sheet, together with a brief statement of comparative results obtained and suggestions for improved methods. A liberal use is made in the stations of flowmeters and other instruments that serve as a guide to the firemen in the proper regulation of their fires.

Since the diagonal line in the plant characteristic diagram is usually a straight line, it can of course be represented by a simple equation, namely:

$$y=a+bx$$

where y is the consumption in a given en period in barrels or pounds, x the kilowatt-hours generated in the same period, and a and b are constants.

Evidently the constant a is equal to y when x=O, or in other words a represents the quantity of oil burned for zero load; that is, the amount required to keep up steam on the boilers, keep the turbine running up to speed, operate the vacuum pumps and other auxiliaries, and keep the entire plant in readiness to take on load at a moment's notice. Obviously a will be larger if two turbines with their auxiliaries are kept in operation than only one, so that its value depends on the amount of load the plant is expected to take on. Where a plant is operated as a stand-by to a hydro-electric system and is kept in readiness to instantly pick up its full load in case of trouble, a will have a higher value than where it is possible to gradually shut down the turbines one after the other as the load falls. The constant b evidently represents the additional amount of oil burned in proportion to the load carried on the plant. It determines the slope of the line in the diagram, and is large for uneconomical turbines or engines and small for the most efficient types. The equation of the line in Fig. 2 in terms of barrels of oil and kilowatt-hours for an eight hour shift is—

$$y=120+0.0041\ x$$

Other Uses of The Plant Characteristic Diagram

The characteristic diagram may be used for many other purposes besides the overall efficiency of the plant. By plotting the steam generated against the oil burned in one diagram, and the steam consumption against the kilowatt-hours generated in another, it is possible to study the boiler-room and engine-room operations separately, and thus quickly locate the cause of low efficiency. By setting separate standards for the boiler-room and engine room crews, responsibility can be more definitely fixed and the advantages of the system of operation greatly enhanced.

Since boiler efficiency usually decreases quite rapidly as the capacity increases above the boiler's rating, a single boiler will naturally have a curved characteristic. In a plant containing a large number of boilers, however, the boiler-room characteristic will be approximately straight until the load exceeds the economical capacity of all the boilers in the plant, after which it will begin to curve upward. A curved line, based on previous performance, is just as satisfactory as a straight line for setting standards and calculating operating efficiency in the manner described. Fig. 4 shows the power used by electric auxiliaries in a station plotted against the total generation, and is of interest in showing that the points do form well-defined straight lines, and that the same methods may be used for standardizing these items as for fuel consumption and steam consumption.

To sum up, the essentials for securing

the best efficiency in power-plant operation are;

1 A fair standard by which the daily performance can be measured and compared with previous results, at the same time giving the operating men a definite goal to work to.

2 Means of comparing results obtained by different shifts of one plant or the crews of different plants, and the posting of this comparison so that the men can see the results of their efforts.

3 A system of reports that keeps up the interest of the men, combined with suggestions and advice that show where losses occur and how they may be avoided.

If the operating men are kept interested, see the results of their work, and have a definite standard to reach, they will do their best. As interest flags some sort of bonus or prize for the crew showing the best operating efficiency will stimulate them to greater effort, and by guiding this effort by means of thoughtful analysis of the technical features of the power plant, maximum efficiency may be obtained.

TORONTO SECURES NOVA SCOTIA COAL

Expect to Ship Coal Direct From Mines Believes This Will Overcome Shortage Troubles—Low Cost Said To Be Obtainable

Soft coal from the Sydney mines in Nova Scotia arrived in Toronto recently. According to Mr. Malone, western sales manager for the Century Coal Co., it is the intention of his company to deliver this coal direct by steamer to Toronto. Other steamers are at present en route to Toronto with further supplies.

Mr. Malone states that his company has succeeded in landing the Nova Scotia coal in Toronto at an economical cost, thus enabling them to meet the competition prices of coal from the United States. In this connection, Mr. Malone points out that the Turret steamers which are used have capacity for 4,000 tons. Owing to the limited depth of the Cornwall Canal they are obliged to lighter 2,000 tons at the bunkers in Montreal, the remainder of the cargo being brought direct to Toronto. After lightening her cargo in Toronto the steamer proceeds to Port Colbourne and loads grain for Montreal and other eastern points, thus giving the steamer the benefit of cargoes in both directions, the loading in each case, likewise, being accomplished in much faster time than ordinarily required to load freight consignments. This in itself, Mr. Malone states, makes it impossible for the company to compete with coal from the mines across the border. Under present conditions Toronto will be the western point of destination for the eastern coal until such time as the business develops and conditions at other points on the Upper Lakes warrant the transportation of this coal in that direction.

Assurance has been given by several large manufacturers in Montreal and members of the Montreal Harbor Commission that the Nova Scotia coal is equal in quality to that which is brought from Pennsylvania.

Mr. Malone believes that this will prove a practical solution in overcoming shortage conditions at certain seasons of the year, so far as soft coal for manufacturing purposes is concerned.

CANADIAN-BUILT PAPER MACHINES

In the Sept. 22nd issue we mentioned the installation of two 166 inch news machines by the Laurentide Co., Limited, Grand 'Mere, Que. These machines were built in Canada by the Dominion Engineering Works, Limited, at Lachine, Que., and represent a record in Canadian Machine Building. They were ordered in October, 1919. One machine was installed January 5, 1921, and the other February 2?. 1921. While these machines were being built, the makers rebuilt parts of these other machines and turned out a new 90 inch, four cylinder board machine, and 1418 inch Harper Fourdrinier machine, all of which represent a remarkably good rate of production of special machinery in a new plant. Speeds of 1,000 lineal feet per minutes of paper produced have been reached on kraft paper, but these 166 inch machines are now producing newsprint daily at the rate of 1000 to 1030 feet per minute, and the combined product of the two machines averages 160 tons daily.

Machines for operation at such high speeds must necessarily be equipped with all the latest devices for handling the sheet through the machine and for insuring freedom from breakages and getting practically continuous production. When one considers that under the above conditions, the speed of a 30" diameter couch roll is 127 r.p.m., it is evident that the limit of human skill in handling paper through the machine by hand has been left far distant.

The Toronto Harbor Commission have given an option on ten acres of property at $60,000 an acre. The type of industry which proposes locating in Toronto is so far a secret although the very location chosen leads one to believe the new plant will be engaged in the metal working field.

Toronto, Ont.—About half the usual staff of the Massey-Harris Co. went back to work a few days ago to fill a foreign order. Nothing definite is stated as to future prospects.

TOO BUSY TO STOP FOR ANYONE.
—Fitzmaurice in Vancouver Province.

Member of the Audit Bureau of Circulation

POWER HOUSE

OCTOBER 20TH, 1921.

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

T. H. FENNER - - - - Editor
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Exchanging Experiences

A CORRESPONDENT who writes in this issue calls attention to the fact that very few stationary engineers in Canada seem to send their experiences to their technical journal for the benefit of their fellows, while the engineers in the United States seem to be very prolific in this direction. There is no doubt that our correspondent is right, though of course, some of the difference in the amount of correspondence is to be found in the difference in numbers of the engineers in the two countries. The chief reason, is, we believe, the diffidence that so many men seem to have in giving voice to their thoughts in public. This is notable in every gathering of men, whether they are members of any particular profession or merely a gathering of citizens met to discuss some point of general interest. There will be one or two who will more or less monopolise the speaking, and these outstanding speakers will not always represent the best brains of the gathering. However, they are not troubled by bashfulness, but on the contrary have a remarkable degree of self-confidence, which carries them along, while better men sit quietly and listen.

In a gathering of men, of one trade or profession, met together for the purposes of mutual benefit, there are often those who have points that they would like cleared up, or some things that they are absolutely ignorant upon, and they leave the points still in doubt, and remain ignorant of the things they want to know, because they fear that by asking a question they will cause some other member to look down upon them. This state of mind should not be allowed to exist. A man with a question to ask should ask it, without any fear of ridicule, because it is very often the case that there are others in the gathering with exactly the same doubts, holding back for the same foolish reason. They may rest assured that the ones who laugh at them are not the ones who can answer their question, and clear up their doubts. Those that possess the necessary knowledge are those who have gone to the trouble to get acquainted with these points, and have not been afraid to ask questions whenever they had them to ask.

It is the same way in giving others the benefit of experience through the medium of the printed word. The fear of not being able to express one's ideas in proper form, or the feeling that the experience is perhaps not worth while recording, often results in something of value to the profession in general being hidden. It is a pretty safe rule to go by, that any happening in the course of daily work that appears to be of unusual interest to the man it occurs to, will be of interest to others, and not only of interest, but of help. Those great discoverers of other days, who first advanced the theory that heat was not a substance, but rather a form of energy, had lots of opposition to face but they had the courage of their convictions, and the present state of steam engineering is due to that courage. The sum total of engineering knowledge in the world today is only the sum of other men's experience set down and distributed broadcast so that all who wished might benefit. There are men whose only contact with others of their calling is through the medium of their technical journal, and to whom the reading of some plant trouble met and overcome would be invaluable. Is it not worth while to help a brother along the road, even if it involves a little trouble? The knowledge of little things that help in the daily task is just as welcome as the learning of broad principles, and it is only from the man engaged in actual practice that these little tips can come.

Exporting Hydro Power

THERE has been some suggestion that the Hydro Electric Power Commission should export some of its surplus power, which will be available on the completion of the Chippewa development, or on its partial development. It is said that the suggestion has been so far developed that a price of $35 per horse power has been offered by the Commission. We do not know if this is actually the case, but if it is it seems a strange thing that a publicly owned utility in Canada should go to an expense running into hundreds of millions of dollars in order to give cheap power to an American city. The only excuse there is for a publicly owned utility is that the people of the country should benefit from it by getting service at cost. Whether the people have been getting service at cost or under or over cost from the Hydro is not a point that we wish to bring up here, but that an American city should get power from Ontario at cheap rates or any rates at all in order to run industries that are competing with Canadian industries does not seem good business. If the fact is that the development is far in excess of the needs of the Province for a long time to come, it is unfortunate, but part of the price to be paid for an unreasoning belief in the wonders of public ownership. We expect that if any private company in Ontario was to develop part of the waters of the Province and then export them there would be a mighty howl from the friends of the people who are wedded to the public ownership of everything in sight.

TORONTO LODGE C. A. S. E.

Toronto Lodge No. 1 staged the opening celebrations of their new lodge room at Cumberland Hall on October 18th, when there were about one hundred members and friends present. The evening was devoted to entertainment and amusement, and a varied and attractive program was presented. There were twenty numbers on the program which is reproduced here.

One of the most amusing events of the evening was a dialogue, purporting to be taking place between an applicant for a certificate and a member of the board of examiners of the Stationary Engineers. The part of the applicant was taken by Brother Leach, while the examiner was Bro. Turner. The dialogue is good enough to reproduce, and we here do so.

An address was given by the chairman of the examining board, and in the absence of Mr. D. Crockett, the gap was filled by Dad Wickens, who gave the audience a general resume of the history and prospects of the C.A.S.E., about which Dad is well qualified to speak. Mr. Fenner, who was down for a song, was also unfortunately unable to attend, and his place was taken by Mr. Grant Cole of the Cole Trap Co., and Mr. N. Kingsland of Power House, who gave a short address.

Toronto lodge have certainly got away to a fine start in their new home, and we sincerely hope that success will crown their efforts in the future.

PROGRAM

Cumberland Hall, Oct. 18, 1921.

(1) Music—Interlude, "Hot time in the Old Town Tonight."

(2) Welcome to visitors by President of C.A.S.E. (8 p.m.)

(3) Song, "The Maple Leaf," by the whole audience.

(4) Introduction of L. J. Ellis.

(5) Reply by L. J. Ellis to "Visiting Brethren" (8.10).

(6) Song and music. (8.15).

(7) Introduction of J. M. Brown by President (8.30).

(8) Song, "For He's a Jolly Good Fellow" (8.35).

(9) Address by J. M. Brown "The Graded Licenses" (8.45).

(10) Dialogue "An Examining Board" (9.00).

(11) Song and music (9.15).

(12) Introduction of D. Crocket.

(13) Song, "See Him Smiling," etc.

(14) Address by D. Crocket, "The C.A.S.E. Advantages," (9.30).

(15) Song by T. H Fenner (10.00).

(16) Invitation to eats by A. M. Wickens (10.15).

(17) Refreshments.

(18) Vote of thanks to ladies (11.00).

(19) Group photo (11.15).

(20) Dispersal and song, "God Save the King" (11.30).

Entertainment Committee

A. M. Wickens, Chairman; A. E. Wagg, C. B. Turner, Geo. J. Soucy, Ed. Golightly, George Bones, T. Turner, R. C. Leach.

THE EXAMINING OF PROSPECTIVE ENGINEERS.

Personata—Applicant, Bro. Leach; Examiner, Bro. Turner; Clerk, Bro. ———. Scene, office of examining board.

Enter the Applicant—Clerk with roll in hand (to act as prompter). Examiner whittling in corner.

Clerk—How'd you come to blow in here? Applicant—Well, the door was open so I just perambulated along, see?

Clerk—Who are you? Applicant—Oh, just a guy looking for Sir Tificat. Is he here?

Clerk—What do you want? Applicant—The examining board. (Clerk hands him board 1"x12"x4'0").

Applicant—What's that for? Clerk—Board for you to be examined on.

Applicant—Are you the guy that does the examining? Clerk—No, he's busy.

Clerk—Do you want to be examined? Applicant—Yeh, I suppose so, especially if he's too busy.

Clerk (To Examiner, stamps)—There's an awful smart fellow over there wants to be examined, and say he's so sharp that if he ever fell on himself he'd be cut in two in a jiffy.

Applicant—Hello, old top, are you the executioner around this joint? Examiner—Evidently you need an examination; are you fresh from the soil.

Applicant—Say, quit your kidding and let me see how little you fellows know up here.

Examiner—Sit astride the board if you want to be examined, and repeat after me the formula C.A.S.E. or anything else you like best.

(Examiner takes large magnifying glass and examines head of applicant).

Applicant—What's the big idea—do you think it's vacant? Examiner—No, I wasn't thinking at all. Just looking to see if there was any evidence of ashes, coal dust or grease.

Applicant—Well, just look at these hands if you want to find out how much I know about boilers and engines.

Examiner—That isn't the point. We want to find out how much you don't know.

Applicant—Say, old top, if you know anything I don't know, just shoot it out.

Examiner—What questions do you think I should ask you? Applicant—None at all—tell me something instead.

Examiner—What do you want to know? Applicant—How to get Sir Tificat without examination.

Examiner—Go to an employment bureau and tell them you want a job without pay.

Applicant—Say, what's the idea of this examining board anyway—just to get some easy money from us fellers that has to work around steam in winter time, eh?

Examiner—Did you say you liked to work around steam? Applicant—No, I said we had to work around steam in the winter time, and in the summer we like to work around an ice house.

Examiner—Did you find anything in the last ice house you worked around? Applicant—Shhh, B.O.T.A.

Examiner—Have you let off all your steam? If so be still a minute and I——

Applicant—Say, Mr. Examiner, I'd sooner have you talk about steam than stills and worms.

Examiner—Well, what do you know about steam—what is it? Applicant—I know all about it—it's water gone crazy with the heat, and believe me it was some hot last summer.

Examiner—What do you mean by heat and hot? Applicant—Well the heat was so hot that some people said last summer that the weather was almost as hot as "Hell bent for Election."

Examiner—I see you learned something about religion as well as heat and steam. What do you mean by Hell? Applicant—Oh, that's a convenient place to send our enemies in the winter time.

Examiner—What do you know about firing? Applicant—Know, why, all about it—I just got fired.

(Clerk interrupts and suggests asking applicant)—Does he expect to become an expert?

Applicant—Yeh, I'll go buy a white collar and a white shoit and then I'll be an expoit.

Examiner—What kind of an expert will you be? Applicant—Expert! Boiler, Engine, Heater, Condenser, Filter, Economizer, Damp-her regulating, Flue-cleaner, Ash and Coal Conveyer, etc. (Clerk interrupts):—Say, that'll do old sport.

Examiner—What did you have in your plant? Applicant—An engine, boiler. Examiner (interrupts)—But why did you boil the engine? Applicant—To make it tender service for de boss.

Examiner—What do you know about an engine? Applicant—Everything about it, but I never was inquisitive about its internal parts, because familiarity might lead to repair work.

Examiner—What grade license do you want us to grant you? Applicant—The kind that I won't have to pay much for, and when I get it I won't have to work no more.

Examiner—Is there anything else you'd like? Applicant—Yeh, I'd like to tell you fellows what I tell my friends about you, but I can't remember it all.

Examiner—Well, tell us what you do remember? Applicant—Oh, nothing, it ain't so anyway.

Examiner—What? Applicant—Well, I said before I came here that I knew more in a minute than you fellers'd ever know—and now I don't know nothing, but say, I'm going to join the C.A.S.E. and see if they know any more than I do.

Examiner—Well, come back and see us again after they knock off some of the rough corners. Clerk—Just fill in this application card and I'll tell them about your CASE.

Applicant—You can't tell, I may be the Past President o the Grand Lodge of the C.A.S.E. yet.

Examiner—Yes, and I may revise your constitution an guard your inner courts yet.

(Curtain.)

Flourish and exeunt.

The Increased Use of Fuel Oil

FUEL oil, for use in oil burning equipped plants, has increased remarkably during the past year. J. J. Tyrell, in "Textile World," gives some interesting figures relative to this subject. Speaking of the oil burning boilers used by textile mills in New England and New Jersey, he says that approximately 50 textile plants with over 400 boilers were converted from coal to fuel oil. The oil consumption exceeds 4,500,000 barrels, displacing about 1,125,000 tons of coal per year.

The outstanding fuel oil installation in point of size, according to Mr. Tyrell, is that of the American Printing Company, at Fall River. The main storage consists of a concrete tank with a capacity of 640,000 gallons. This tank is about 30 feet from the boilers and oil is fed to the boilers by means of pumps. The storage tanks are provided with heating coils to hold the temperature of the oil to approximately 100°F. These heaters utilize the exhaust steam from the oil pumps.

In selecting apparatus to handle the oil some attentio must be given to its quality; that is to say, whether it i light or heavy. It is my opinion, says Mr. Tyrell, that al though the first cost of the apparatus to handle the heavie oil is greater, it is economical from an all-around view point to install the apparatus to handle the heavier oil. Suc installations will allow the engineer to take advantage of th market without regard to the nature of the oil.

Developments during the past year were chiefly concerne with the design and development of furnaces for high overloads. It is, of course, generally known that it is not economical to operate boilers on overload for any length of time. Yet, it is necessary to have them operate over shor intervals to take care of big loads. In concluding, he says that the men who burn the oil ought to be given apparatus to guide them to the best way to get efficient results, and to be certain that they know the purpose of such apparatus when installed.

THE POWER PLANT OF THE EASTERN CAR COMPANY

(Continued from page 29)

is swung on its thread so as to elevate or lower the point of discharge.

The principle upon which the separator works can be demonstrated by taking a U-Tube and filling half full of water, put some engine oil in one side. The oil will displace the water until the leg containing oil is full. It will now be noticed that while the oil leg is full the water leg is not full, but the water level is lower than that of the oil. This is due to the difference in specific gravity.

The use of the collector separator just described permits the oil from the sight feeds to be fed liberally to the engine bearings, since it is again recovered. There is no attempt made to save the oil used on the auxiliaries, and this amount must be added to the Cross filter tank each day, thus keeping the viscosity of the oil from getting too low. It is not our intention to recommend this apparatus as being better or even as good as some of the filter separators on the market, but it is better than nothing and costs very little. However, the apparatus described here seems to be very efficient and is a great improvement on the old paint can or oil cask frequently encountered.

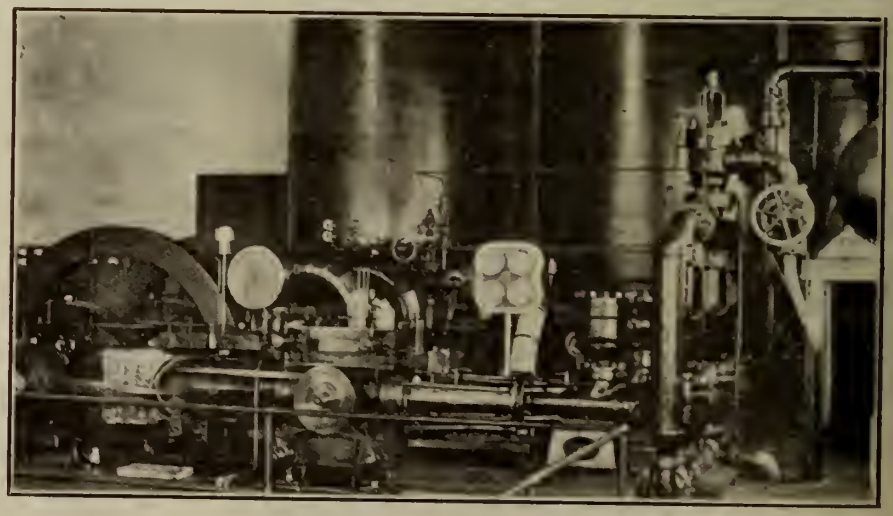
WOODSTOCK C. A. S. E.

C.A.S.E. Lodge No. 37, Woodstock, held a meeting recently at which a lecture was delivered on Boiler Settings and Combustion Space. Mr. C. Andrews was present and gave some interesting facts on this subject. Bro. Arnup was in the chair, and it is satisfactory to note that owing to the interest shown by Bro. Arnup and Bro. Watts, a sum of $75 has been collected towards the purchase of a lantern for the use of the lodge. It is hoped that at the next meeting the lantern will be ready for use, and interesting evenings will be forthcoming. Woodstock Lodge has now twelve new members on the books, and some more are expected to join in the next few weeks. The meeting was brought to a close by the passing of a hearty vote of thanks to Mr. C. Andrews, for his interesting lecture.

The Toronto office of the Independent Pneumatic Tool Company has been removed from 32 Front Street West to No 163 Dufferin Street. The new location will give this company larger space and increased stock facilities. The Toronto Office will remain in charge of Mr. Willima McRae.

COLOR VERSUS HARDNESS

Quite often a workman spends considerable time in carefully drawing the temper of a piece of carbon steel, only to find to his dismay that it is soft, while yet the color is real light brown! It upsets his ideas of steel and hardening. Really, the trouble is that the piece was not hard when taken from the water. Either it was not hot enough to harden when dipped, or else it was removed from the bath too soon and drew itself before the black was polished off. Test the piece as soon as taken out of the hardening bath—it is quite apt to prove soft. Remember that the **same** colors can be produced on a piece of mild steel but they do not indicate a state of hardness.



Hydraulic pump and accumulators.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

CONSUMPTION OF STEAM PUMP

Question.—What is the consumption of a feed pump size 14 inches diameter x 24 inches stroke, making 40 strokes per minute, with a steam pressure of 180 lbs. per square inch. The pump in question is a Weir?

Answer. — The consumption of a steam pump will depend on whether or not the steam is carried the whole length of the stroke or otherwise. With the make of pump in question, it is usual when working properly to cut the steam off at about seven eights of the stroke, finishing the stroke expansively. The consumption in the two cases, first carrying the steam the whole stroke, secondly cutting off at .875 of stroke. The volume of the cylinder is 14 x 14 x .7854 x 24 cubic inches, and this divided by 1728 will give cubic feet per stroke. The volume per stroke or cylinder volume multiplied by the number of strokes per minute will give the cubic feet per stroke. The volume per stroke or cylinder volume multiplied by the number of strokes per minute will give the cubic feet of steam per minute. Multiplying this by the weight of a cubic foot of steam at the pressure given will give the weight of steam per minute, and multiplied by 60 the consumption per hour.

The working will be

$$\frac{14\text{x}14\text{x}.7854\text{x}24\text{x}40\text{x}60\text{x}.4241}{1728} = 211.56 \text{ lbs. per hr.}$$

If the pump is cutting off at seven eights the consumption will be

$$211.56 \text{ x } .875 = 185.11$$

The weight of a cubic foot of steam at 180 lbs. gauge is .4241 lbs.

LIFT OF SAFETY VALVE

Question.—It was stated in the September issue of Power House that a spring loaded safety valve will raise from its seat a distance in proportion to the pressure of steam over and above the pressure it is set for. That is a 6 inch. spring would lift one quarter of an inch at 104 lbs. Will it raise ½ inch at 108 lbs. and 1 inch at 116 lbs. Is a ball and a lever valve subject to the same rule and if not how does it differ?

Answer.—Our correspondent has evidently misunderstood the statement in the issue he speaks of. What was stated was that the fact of the valve lifting produced a greater compression of the spring in direct proportion to the height the valve lifts, and for this reason a lip was formed on the valve to give a greater area to counteract this extra compression of the spring. The valve lifts an amount sufficient to give an opening about equal to the area of the valve. A lever safety valve is not subject to the same rule, as there is no extra leverage due to the valve lifting, such as the extra compression on the spring of a spring loaded safety valve. In connection with the amount of lift, supposing we have a valve of 3 inches diameter, its area would be 7.06 inches. Now in order to obtain the same area the valve must lift an amount equal to the circumference divided into the area, or 3 x 3.1416 divided into 7.06, the lift therefore being .677 inches. Now if we had a spring say 10 inches long, and the pressure the valve was set for was 150 lbs. per square inch, the extra compression of the spring due to the lift of the valve would be

$$\frac{.667 \text{ x } 150}{10} = 10.05$$

so that the total compression of the spring for that lift would be 160.05 lbs. This extra compression would be carried by the increased area of the valve due to the lip.

LEVER SAFETY VALVE

Question.—What would be the weight in pounds of a weight placed on a safety valve lever, the diameter of the valve being 3 inches, distance from fulcrum 3½ inches, length of lever 42 inches, boiler pressure 110 pounds per square inch? The weight of the lever and valve are not given.

Answer.—The weight multiplied by its distance from the fulcrum of the lever, must be sufficient to counterbalance the load due to the pressure on the valve multiplies by the distance of the valve from the fulcrum, neglecting the weight of the lever and valve. Thus the load on the valve will be the area of the valve multiplied by the pressure per square inch, and the distance from fulcrum.

$$110 \text{ x } 3 \text{ x } 3 \text{ x } .7854 \text{ x } 3.5 = 2721.4$$

and the weight to balance this will be

$$\text{Weight x } 42 = 2721.4$$

Putting this in the form of an equation we have, calling the weight W

$$110 \text{ x } 3 \text{ x } 3 \text{ x } .7854 \text{ x } 3.5 = W \text{ x } 42$$

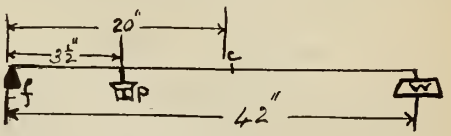
$$W = \frac{2721.4}{42}$$

$$W = 64.79$$

Say 65 lbs.

Supposing that we have the weight of the valve and the weight of lever given, the distance of the centre of gravity of the lever being 20 inches from the fulcrum. The valve weighs 5 lbs. and the lever weighs 10 lbs.

The total upward pressure on the valve will be due to the pressure multiplied by the area, less the weight of the valve, multiplied by the leverage which is 3½. The weight opposed to this will be the weight of the lever acting at the distance of its centre of gravity from the fulcrum, and the weight acting at a distance of 42 inches from the fulcrum. The equation will then be



P = Total Load on Valve
C = Weight of Lever = 10lbs
V = " " Valve = 5lbs

$$(P-5)3\tfrac{1}{2} = (C \text{x } 20) + W \text{x } 42$$

$$W \text{x } 42 = (P-5)3\tfrac{1}{2} - C \text{x } 20$$

$$W \text{x } 42 = (3 \text{x } 3 \text{x } .7854 \text{x } 110 - 5)3\tfrac{1}{2} - 10 \text{x } 20$$

$$W \text{x } 42 = 2703.75 - 200$$

$$W = \frac{2503.75}{42}$$

$$= 59.6$$

Say 60 lbs.

VOLUME AND TEMPERATURE OF AIR

Question.—Kindly explain if the following is right, or if not where I am wrong. I understand a pound of air at 62 F. has a volume of 13 cubic feet, and the absolute temperature is 522 F. Now will a temperature of 522 x 2 1044 F equal 26 cubic feet and double that absolute temperature equal 52 cubic feet. Will the volume of one pound of air at an absolute temperature of 261 F be equal to 6.5 cubic feet. Does steam expand and compress as air does?

Answer.—According to Boyle's law, the pressure and volume of a gas vary in direct proportion, that is pressure x volume equal a constant. This is known as the isothermal law, because the change of volume and pressure are supposed to take place without any loss or gain of temperature. It is expressed pv = constant. Another law, known as the second law of gases, takes into account absolute temperature, and is known as the adiabatic law, or Gay de Lussac's law. It is sometimes express-

ed as "Equal increments of temperature give equal increments of volume at constant pressure, or equal increments of temperature give equal increments of volume at constant pressure."

The law is based on the fact that for every degree of heat added to air in a cylinder, in which is contained a piston which is free to move, the volume of air will increase by 1/460.66 of its volume if the Fahrenheit scale is used, or 1/273 rd of its volume if the Centigrade scale is used.

If we have one pound of air at an absolute temperature of 522 degrees and increase it to an absolute temperature of 1044 degrees, we have increased the heat by 524 degrees. The air being originally at 62 degrees, the ratios of expansion per degree will be 1/522.66. The volume of gas after having a given amount of heat added can be obtained from the following formula:

Initial volume absolute temperature plus acquired temperature, divided by absolute initial temperature = heated volume or

$$\frac{1 \times 460.66 + 584}{522.66} = 2 \text{ volumes}$$

If the volume remains the same and the pressure is increased we get the ratio of expansion per degree 1/522.66. The difference or the heat added is 524 degrees, the initial pressure being 14.7 absolute. Then the ratio, multiplied by the difference in temperature, and the initial pressure will give the new pressure 1/522 x 524 x 14.7=14.7 lbs gauge pressure or 29.2 absolute. Another formula gives

$$\frac{\text{Abs, pres. x difference in temperature}}{\text{abs, temp.}}$$

$$14.7 \;/\; 522 \times 524 = 14.7$$

These two are practically the same and give the gauge pressure. The following gives absolute pressures.

Steam follows the same law as air in its expansion and contraction, but of course there are corrections to be made for moisture etc, and the expansion of air or steam in an engine cylinder does not quite follow either the adiabatic or the isothermal law, but lies somewhere between them.

COMBUSTION PECULARITIES

Question.—I have noticed when firing a coal fire that the flames reach a long way beyond the bridge wall as long as the furnace door remained shut, but as soon as the door was opened the flames would shorten up and disappear. On again closing the door, the flames would lengthen out again. The coal burned when this was noticed was a cheap Canadian lignite. Now can you explain if I was allowing too little air to pass through the furnace door, to complete combustion, so that when the door was shut the flames were the result of late combustion, and when the door was opened the combustion was taking place over the coals?

On another occasion I noticed with wood fires and sometimes with coal fires that I did not have a long flame, but on allowing air to enter the combustion chamber back of the bridge wall a large flame would burst out like a small explosion, and continue as long as the air was admitted. I pulled off the man hole cover on the clean out hole of the combustion chamber on a H.R.T. boiler, the draft drawing in a large volume of cold air, the result being an explosion that drove sparks and flames out of the door with considerable force. To me these two experiences seem to differ and I am at a loss to know which if either was due to incomplete combustion.

Answer.—When burning low grade coal, or coals containing a high percentage of volatile gases, the hydro carbons are distilled from the main body of the carbon, and are ignited if there is sufficient air burning with a long flame. If there is too much air the gases will not be ignited, but will flow on through the combustion chamber and tubes in the form of fine carbon, which becomes soot when deposited. Striking against the heating surfaces of the boiler will cool the gases down below ignition point sometimes. The reason that the flames shortened up when the furnace door was opened was that too much cold air was admitted, and therefore combustion was deferred, this accounting for the disappearance of the flame. Now in the second case it is evident that a large amount of partially consumed gas was present in the combustion chamber and the sudden admission of air enabled it to complete combustion so quickly that it became in the nature of an explosion. This is not an unusual thing. Under certain conditions large quantities of gas are generated in a boiler furnace, much the same as in a gas producer, and the sudden admission of air produces the explosion. The ordinary house furnace, fired with anthracite coal, gives a very good example of this. If the firebox is filled up with coal, until no fire can be seen, and left with dampers partially closed for a while, and the door is then suddenly opened, the gas which has formed on top of the coal will ignite with a sudden puff like a miniature explosion.

DUPLEX PUMP TROUBLE

Question:—I have a duplex pump taking its supply from a Moffat feed heater, the valves and plunger packing are in good order, and the pump works well when the temperature of water is low, but when the water gets very hot the plunger slips about 2 inches of its stroke at the beginning of every stroke. Now this pump has always worked well with very hot water up till now. I might say that the only cause that I can see is that the water ways leading from the cylinder to valve chest are partly blocked with scale. Will this cause the trouble with hot water, and if so how can these be cleaned out. It is difficult to get a toll in on account of the curves. Would it be better to apply boiler compound to the heater, instead of direct to the pump, as there is always a lot of scale in the heater. Would it help to keep the pump clean?

Answer:—Restricted water passages in a pump on the suction side may cause a pump to slip when using hot water. The heater is set above the pump to cause a pressure on the water, thus raising its boiling point, and preventing its vaporisation. However, if the water passages are restricted so that the water cannot follow the plunger up, there will be an effect some thing like wiredrawing, and the pressure on the water will be lowered, thus allowing a small amount of it to vaporise. This will cause the plunger to slip.

It is unusual for a pump to become choked with scale, and in order to clean it would perhaps be best to fill it up with a good strong solution of caustic soda, and leave it stand for as long as possible. The fact that the heater always has a lot of scale, and that the pump also has scale, would seem to point out the necessity of more frequent cleaning out of the heater. The presence of scale in the heater also shows that the heater is doing good work by precipitating scale before the water leaves the heater. The addition of a compound to the water in the heater might be helpful, but it is always necessary to look out for corrosion when doing this.

BOILER COMPOUND FEEDER

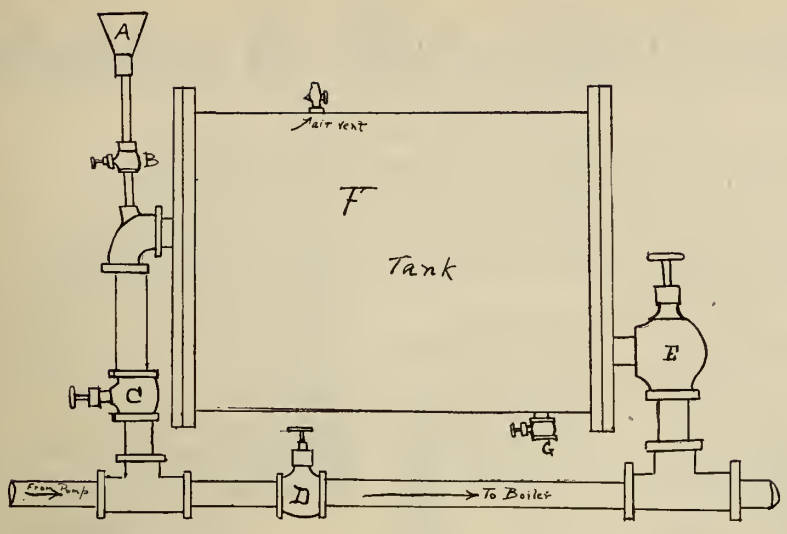
By James E. Noble.

A large number of boiler compound feeders have been described. The enclosed diagram shows the old one in a new design. A B being the funnel and filler valve, C and E the tank control valve, G the emptying valve. The tank can be made from large pipe with caps or flanged ends. By opening and closing the different valves, the tank can be emptied of water, filled with compound, etc., without stopping the operation of the feed water pump. The compound does not pass through the pump, therefore if soda ash or caustic soda is one of the chemicals in the compound, the fear of injury to the pump packing or valves is done away with.

By the way what is the matter with the Canadian engineers. Why do they not give your readers some of their power plant experiences. I note that the U. S. engineering journals print many interesting letters in every number. I do not want to "nose" in, but I sure would like to see you try and stir them up a bit. We all know where to get the high class stuff, in the text books. It is only in our engineering journals that we can find the real interesting stuff, and believe me, although I have been over thirty years in the good, old engineering game, the "simple stuff" very often proves more interesting than the "high brow" articles. Not to everyone of course, but I believe to the majority.

Editors Note—We agree with Mr. Noble that many more power plant engineers could contribute interesting experiences if they would take the trouble.

(Continued on page 39)



Boiler compound feeder.

BOILER COMPOUND FEEDER

(Continued from page 38)

It is only the bringing together of different men's experience that builds up the technique of any profession, from lumbering to doctoring. In contributing to your technical journal you are helping others, as well as yourself.

SAFETY ELECTRICAL APPLIANCES FOR MINES

One of the drawbacks of using electrical apparatus in fiery mines is that explosions taking place inside switch boxes and other apparatus are liable to produce a flame outside, and ignite the gas in the mine. It is practically impossible to make the casing of the electrical apparatus strong enough to withstand the force of such explosion; and if a safety valve is fitted to prevent the cracking of the casing it is likely to permit the flame to escape with disastrous results. A solution of this difficulty has been devised by an electrical company in Great Britain. The cover of the casing is held down by bolts with a spring cover so arrranged that when an explosion occurs the whole cover lifts by not more than one theirty-second of an inch. This lift is sufficient to relieve the internal pressure, but the gases, in escaping through the narrow passage between broad pieces of metal, are cooled sufficiently to prevent the passage of flames. Stringent tests of this ingenious device has proved it to be completely successful.

COAL STORAGE AS AN AID IN COAL BUYING

The coal bill of a public utility is such a large percentage of the total operating cost, and the amount of coal consumed per unit of the delivered commodity is so true an index of the physical condition of the property, that in capably handled plants a great deal of attention has been given to both the delivered price of the fuel and the efficiency of the various power units which make available the energy stored in the coal.

In buying coal, consideration is given to the steaming qualities of the various classes offered and a comparison made of the delivered price, tests are often made to determine the test B.T.U.'s of the product as delivered, and in many cases the price to be paid has been determined upon this basis. In using coal there have been inumerable devices offered which would increase the ability of the boilers to convert the stored energy into heat, and careful design with care in operation has effected wonderful economics in power plant operation.

In general, the buying of coal has been by one of two methods; by contract, wherein the seller agreed to furnish the output of a certain mine, or from a certain district; or by the purchase in the open market of such coal as is needed to keep the plant in operation. The first plan has many advantages, inasmuch as the seller is interested in seeing that the coal arrives at such times and in such quantities as the plant finds desirable, and the purchaser can usually depend upon a steady supply of approximately uniform fuel. The second plan has more of an element of risk, since the price will probably fluctuate coniderably, and the available supply and quality may be subject to great variation.

Variations of the above plans were tried by the Metropolitan Water District of the city of Omaha, but due to the difficulties that were encountered under each, a study was made to evolve a plan which would obviate a part or all of them. It had been noted that at certain times of the year there would be large offerings of the finer grades of coal at prices that were very attractive, and that the price per ton at the mine would bear no relation to the quality of the coal being offered. A plan by which purchases could be made during these periods, and the coal stored until required for use appeared to offer the maximum advantages in economy and also insure an ample reserve for operating peaks and temporary failures of supply. It was known, however, that it would be impossible to store any considerable quantity of the fuel in the ordinary manner due to heating in the piles, and very great consequential loss in heat value. The solution was obvious, and it only remained to provide a storage of such type that heating could not take place, and of such capacity that sufficient coal might be stored to carry of scarcity and resultant high prices.

In 1913 the District constructed the first pit for the storage of coal under water. It was located parallel to the boiler room and at a sufficient distance away as to provide space for two railroad tracks for the handling of loaded and empty cars. Constructed of concrete entirely below the ground level, it had a capacity of fully submerged coal of 2,500 tons, and when piled about 3,500 tons could be stored. It was anticipated that, due to capillarity, this amount of surcharge could be kept sufficiently damp to prevent heating, but this has not been entirely successful, and small areas considerably above the water line have at times fired, making necessary the use of hose lines to cool the coal piled high.

In 1918 a second pit, having a submerged capacity of 6,000 tons, was added, only slight changes in design being made to conform to the experience with the first pit. With the two pits in use it is possoible to store a sufficient amount of coal to carry the plant about five months, and since there is a small tonnage moving to the station at all times it is possible to make practically all purchases during the semi-annual periods of low prices.

The coal is handled from cars to pit by a 25-ton steam locomotive crane equipped with clam-shell buckets, and the same machine takes coal from the pit for filling the hoppers built into the roof, from which the supply is distributed to the boilers by a larry in the boiler room. The same crane also removes the cinders from a pit located at the end of a tunnel passing under the boiler room floor in front of the ash dumps.

Low prices of coal are due in general to two factors. The most important is that there is an excess of screenings at such times of the year as there is a large movement of screened or prepared sizes and with no appreciable market for the finer grades at steam plants having small storage capacity. This occurs in the spring and fall, and it is often possible to obtain very low prices on grades that are highly desirable, and in such quantities as are determined only by the unloading capacity of the receiving plant. The second element is the so-called spot coal. Companies having contracts with the steam users for their requirements must have moving at all times sufficient coal to supply the wants of their customers, and oftentimes sudden warm weather will cause a considerable tonnage to be in transit or actually arrived at destination for which there is no storage

(Continued on page 41)

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	27 00
1¾-in.	29 75	24 00
2 -in.	29 25	22 00
2½-in.	44 75	28 00
3 -in.	49 25	34 00
3¼-in.	.....	42 50
3½-in.	63 50	37 50
4 -in.	85 00	48 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$4 25	$3 90
Plates, ¼-in. up	3 75	3 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.09	20.13	19.90	24.04
1½	19.19	24.06	23.79	27.84
2	25.72	20.13	19.90	24.04
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

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Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union. 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ....base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal	06
Lard Oil, per gal	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15%
Standard	15 to 40%
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets. base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13½
X L C R	14½		

Colored

Lion	13½	Popular	10½
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrow	30	Anvil	22
Axle		Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Gross Toronto
Tin	$39 00	$40 00
Spelter	7 75	7 50
Lead	5 75	7 50
Antimony	8 00	8 25
Aluminum	34 50	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Graton & Knight Leather Belting

Improved methods and the most expert tanners in the world produce leather that is tanned especially for Graton & Knight Standardized Leather Belting. The leather is chosen for the kind of belt it must make.

All users of belting are learning that it is safer, simpler, more economical in every way, to discard complicated belting specifications and buy belting on the basis of Graton & Knight Standards.

Fairbanks-Morse engineers will analyze the requirements of a single machine, or an entire mill, without any obligation, and make their recommendations that will ensure the right belt for the job, whatever it is.

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

Halifax				Calgary
St. John	Ottawa	St. Catharines	Winnipeg	Edmonton
Quebec	Toronto	Windsor	Regina	Vancouver
Montreal	Hamilton	Fort William	Saskatoon	Victoria

4-9 6

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

COAL STORAGES AN AID IN COAL BUYING

(Continued from page 39)

available, and for which there is no sale among those who are generally in the market. Brokers may have many cars due to the same causes, and a resulting weak market forces the spot coal to a price which makes the price attractive to the plant that made the neccesary invesment to enable it to take advantage of such conditions. And the coal dealer or broker is not at all adverse to having a dump, for he may be reasonably sure of disposing of surplus tonnage, even though he must take a loss that would only be greater had he not had such an outlet.

While an accurate check has not been possible with this plan of coal buying, the management feels sure that in the case of each pit the entire cost of construction was wiped out during the first year of operation, and this in addition to the feeling of security that came from having at all times an ample reserve of the plant's most essential supply.—From "The American City."

METALPAC FLEXIBLE ALL-METALIC PACKING

A new metallic packing "Metalpac" has recently been put on the market by the Valve Engineering Co., Toronto. "Metalpac" is composed of continuous metallic sheets fed through a bath of lubricant and crinkled in such a way that the material inside the soft braids of copper, which forms the outside covering, is as pliable and compressible as the outer surface and at the same time indestructable against the highest pressures. All materials used in the manufacture of "Metalpac" are the best obtainable and are treated in the course of manufacture with graphite. When the packing is put in the stuffing box, the graphite is compressed into the packing, making it almost frictionless and giving it a perfectly smooth and permanent bearing surface. The packing, which is made in continuous lengths, is very flexible and will hold together without the aid of fibrous material; the possibility of flaking are therefore eliminated.

"Metalpac" may be used for almost any kind of service such as high pressure hydraulic rams, hot and cold water pumps, ammonia compressors, pumps handling oils and chemicals. For steam service, it is an ideal packing for high pressure steam engine rods and valve spindles, also for throttle valve spindles. "Metalpac" resists heat up to 800 deg. Fah., and can be put up for specially high temperatures; it is therefore quite suitable for superheat steam. "Metalpac" is made in coil ofrm, in all sizes by sixteenths, and can readily be cut to make rings if required. It is recommended only for rods or plungers that are running in line and that are not scored or shouldered.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

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American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto.
Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Rochester, N.Y.

AIR METERS
Bailey Meter Co.

ALLOYS, BRASS AND COPPER
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Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal,

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa
York Mfg. Co,, York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

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Can. Fairbanks-Morse Co,, Ltd., Montreal.

ARCHES, BOILER AND COMBUSTION
Jointless Fire Brick Co., Chicago, Ill.

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Can. Johns-Manville Co., Ltd., Toronto.

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W. J. Brown (Tucks), Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York, N.Y
Garlock Packing Co., Hamilton, Ont
R. C. Miller Oil & Supply Co., Ltd., Montreal.

ASBESTOS PACKED COCKS
Beldam Asbestos (Canada) Co., Toronto.
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

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Magnolia Metal Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Mueller Mfg. Co., Ltd., The.

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W. R. Sexton Co., Toronto.

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Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

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BELLS
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BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
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Dominion Belting Co., Hamilton, Ont.
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BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
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R. C. Miller Oil & Supply Co., Ltd., Montreal

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BELTING, CONVEYOR
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Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
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BELTING, LEATHER
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Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
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BELTING, RUBBER
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Gutta Percha & Rubber Limited, Toronto.
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R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Sexton Boiler Setting Co., W. R., Toronto.

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Sturtevant Co., B. F., Toronto, Can.

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Arthur S. Leitch Co., Ltd., Toronto.
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Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

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CHAINS, MALLEABLE, DETACHABLE AND RIVETED
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CHAIN WHEELS
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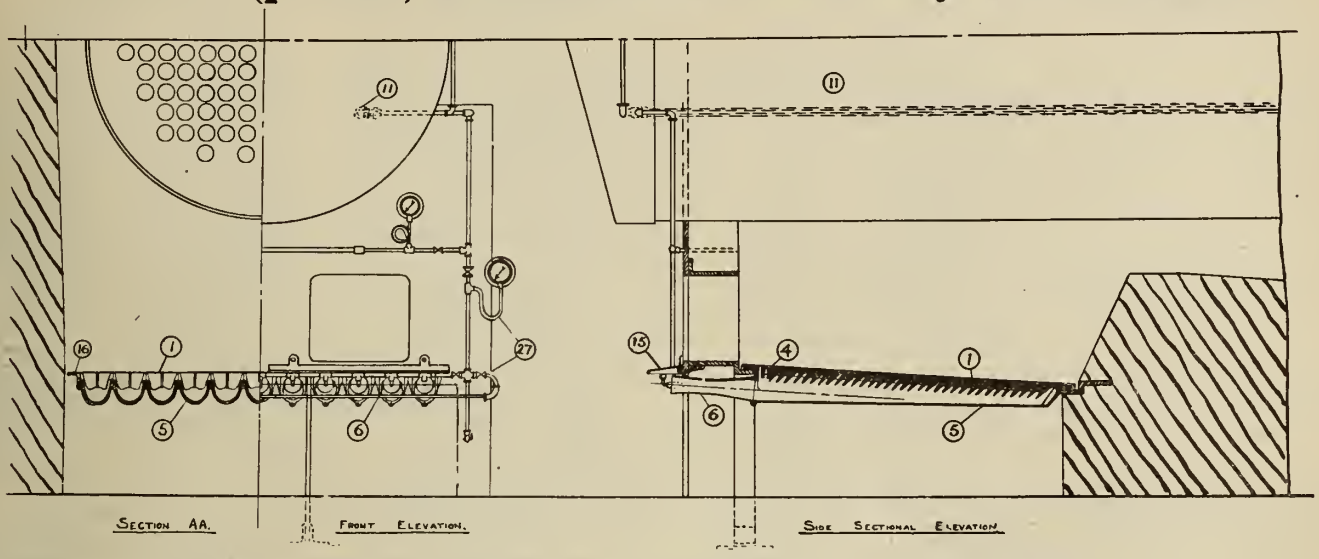
Turbine (patent) Furnace for Externally Fired Boiler



1. Removable fire bars. 5. Air trough. 11. Superheater. 16. Side extension.
4. Locking bar. 6. Air injector. 15. Ash guard. 27. Steam fittings.

Also supplied for internally fired boilers. Write for particulars of the performance of the Turbine (patent) Furnace—using coal slack or coke dust. If you have cheap low grade fuel available let us furnish you with full information at once. Over 1,100 of these furnaces are giving satisfactory service in Britain now.

Manufactured by:

The Turbine Furnace Co. Ltd. London, England

Sole Canadian agent:

PERCY A. GOEPEL, 525 Pender W. VANCOUVER

The Annual Directory Number of

POWER HOUSE

Will Be Issued November 20

This issue presents a splendid opportunity for advertisers of Power Plant Equipment to bring their name and lines favorably before the Canadian trade.

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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal.

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Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
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Gelinas & Pennock, Reg'd, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

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Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Smart-Turner Machine Co., Ltd., Hamilton

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Canadian Link-Belt Co., Toronto.

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Smart-Turner Machine Co., Ltd., Hamilton

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CRANES, PORTABLE
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York Manufacturing Co., York, Pa.

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Bowser Co., Ltd., S. F., Toronto, Ont.

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MacGovern & Co., Inc., Montreal, Que.

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ECONOMIZERS
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

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Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
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Northern Electric Co., Ltd., Montreal.

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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.

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H. Mueller Mfg. Co., Sarnia, Ont.

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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
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Leonard & Sons, Ltd., E., London, Ont.
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Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal Que.
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Leonard & Sons, Ltd., E., London, Ont
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

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Robb Engineering Works, Ltd., Montreal

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Goldie & McCulloch Co., Galt.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

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Waterous Engine Works Co., Brantford
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Sturtevant Co., B. F., Toronto, Can.

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Sturtevant Co., B. F., Toronto, Can.

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Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
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Laurie & Lamb, Montreal.
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Darling Bros., Ltd., Montreal, Que.
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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
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Jointless Fire Brick Co., Chicago, Ill.
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FITTINGS
Crane's Limited, Montreal.

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Crane's Limited, Montreal.
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Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
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Frick Co., Waynesboro, Franklin Co., Pa
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Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co. Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal

MACHINERY, TRANSMISSION (POWER)
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B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y

METERS
The Bailey Meter Co., Cleveland.
Dominion Flow Meter Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto

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METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

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Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

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E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
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Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
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Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

Who was the Third Man?

WHEN the retirement of Sir Robert Borden as Premier of Canada was first announced, three outstanding men were considered as his possible successors. Their names were displayed prominently in every Canadian newspaper. The present Premier was of course one of the men mentioned. Sir Geo. Foster another. Who was the third man? You would remember him no doubt if his name were displayed prominently in the daily press to-day—but he has retired from the political arena, and his name is seldom mentioned.

How easily names slip from the memory when they cease to be given publicity.

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Reliable technical newspapers in Canada are those included as members of Canadian National Newspapers and Periodicals Association. Their circulation is bona-fide and their editorial practice is carefully guarded, in fact their whole policy must conform to the highest standards else they would not be eligible to membership in the association.

Canadian Machinery

Power House

Canadian Foundryman

Marine Engineering

Each of these technical newspapers is a member of the Canadian National Newspapers and Periodicals Association.

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153 University Ave., Toronto

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Lunkenheimer Co., Cincinnati, Ohio.

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Beveridge Supply Co., Montreal.
W. J. Brown (Tucks), Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
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PAINTS
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PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Pratt & Cady, Hartford, Conn.
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Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

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Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
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Pratt & Cady, Hartford, Conn.

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Smart, Turner Co., Hamilton, Ont.

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The John H. McGowan & Co., Cincinnati, Ohio.
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Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

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Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
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Smart-Turner Machine Co., Hamilton.

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
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Darling Bros., Ltd., Montreal, Que.
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Goldie & McCulloch Co, Galt.
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Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Smart-Turner Machine Co., Hamilton.

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

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The Superheater Co., Ltd., Montreal.

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Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

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Can. Link-Belt Co., Toronto, Ont.

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Can. Link-Belt Co., Toronto, Ont.

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Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

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Waterous Engine Works Co., Brantford.

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Robb Engineering Works, Ltd. Montreal.
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Can. Fairbanks-Morse Co., Montreal.
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Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
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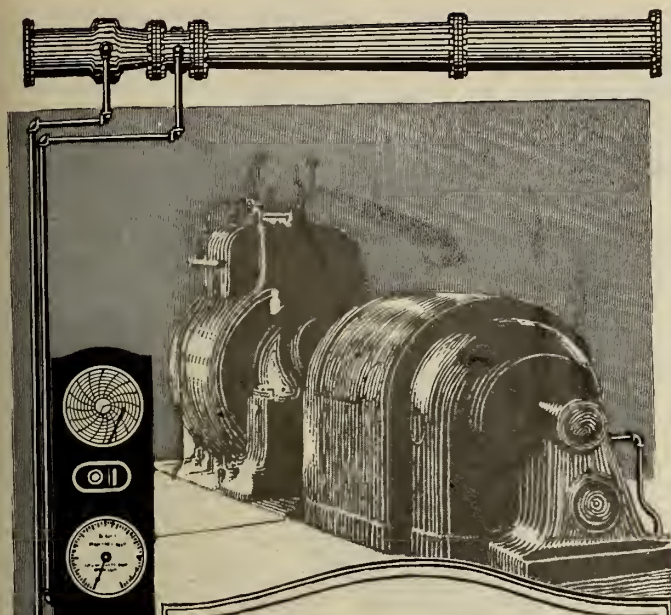

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Power plant records tell the efficiency of the plant to-day and furnish a means of comparison with the results obtained a day, a month, or a year back. The

VENTURI METER

by indicating, registering and recording the rate of flow to the boiler reveals immediately any condition detrimental to economical boiler operation and furnishes an indelible record of its import and duration.

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Still Best After Test of 8 years

Invariably manufacturers wishing to prove the mechanical merit of anything resort to a rigorous test of some sort.

Abundant proof of the superiority of the Steam Trap Sarco over the costlier, more cumbersome bucket or float type of trap is furnished by two New York manufacturers who replaced float traps with Sarco Traps more than eight years ago.

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When steam is shut off at night the Sarco opens automatically and stays open until steam is turned on again. When steam comes on in the morning it forces all the air out and closes the trap, which stays shut until condensation again opens it.

You can install the Steam Traps Sarco for one-third the cost of bucket or float traps and they'll do the same work.

As evidence of Sarco dependability, we quote just a few names of prominent Sarco users:

New York Central Railroad; Pennsylvania Railroad; Erie Railroad; D. L. & W. Railroad; Consolidated Gas Company; Standard Oil Company; Atlas Powder Company; William Cramp & Sons Shipyards, and many, many others.

Let us send you a Sarco on 30 days' trial. If you are willing to part with it at the end of this period, send it back and it will cost you nothing. Write for booklet J-20.

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Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

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Bailey Meter Co.

STEAM CALORIMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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B. F. Sturtevant Co., Boston, Mass.

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Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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The Superheater Co., Ltd., Montreal.

SUPERHEATERS, STEAM
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Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

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Canadian Johns-Manville Co. Ltd., Toronto.

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MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

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Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

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Imperial Oil, Ltd., Toronto.
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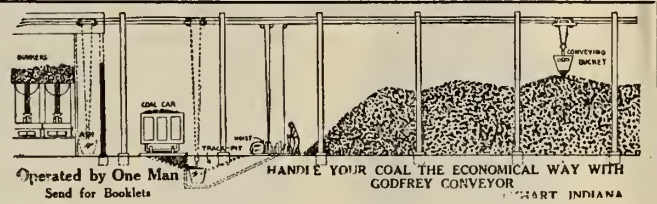

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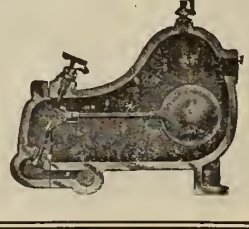

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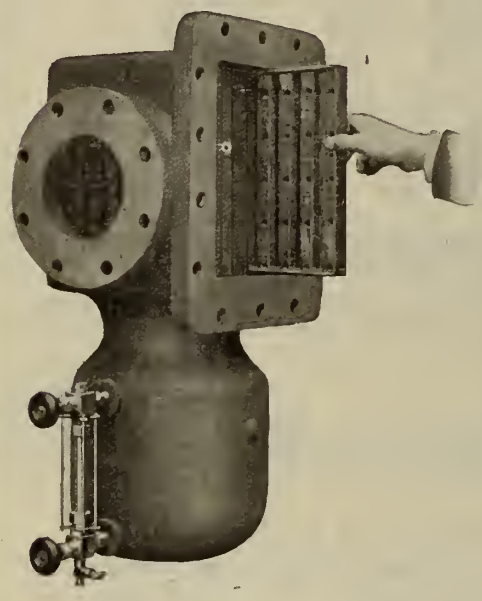

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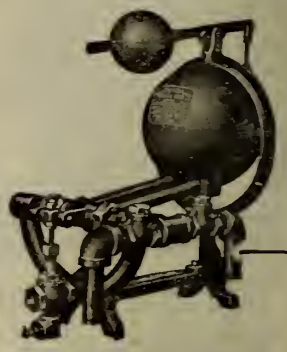

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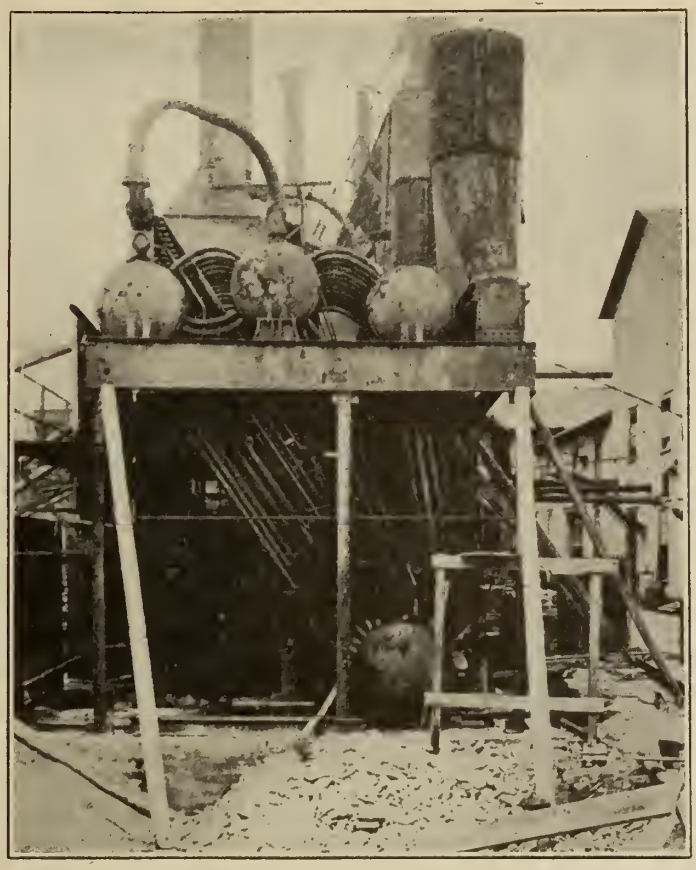

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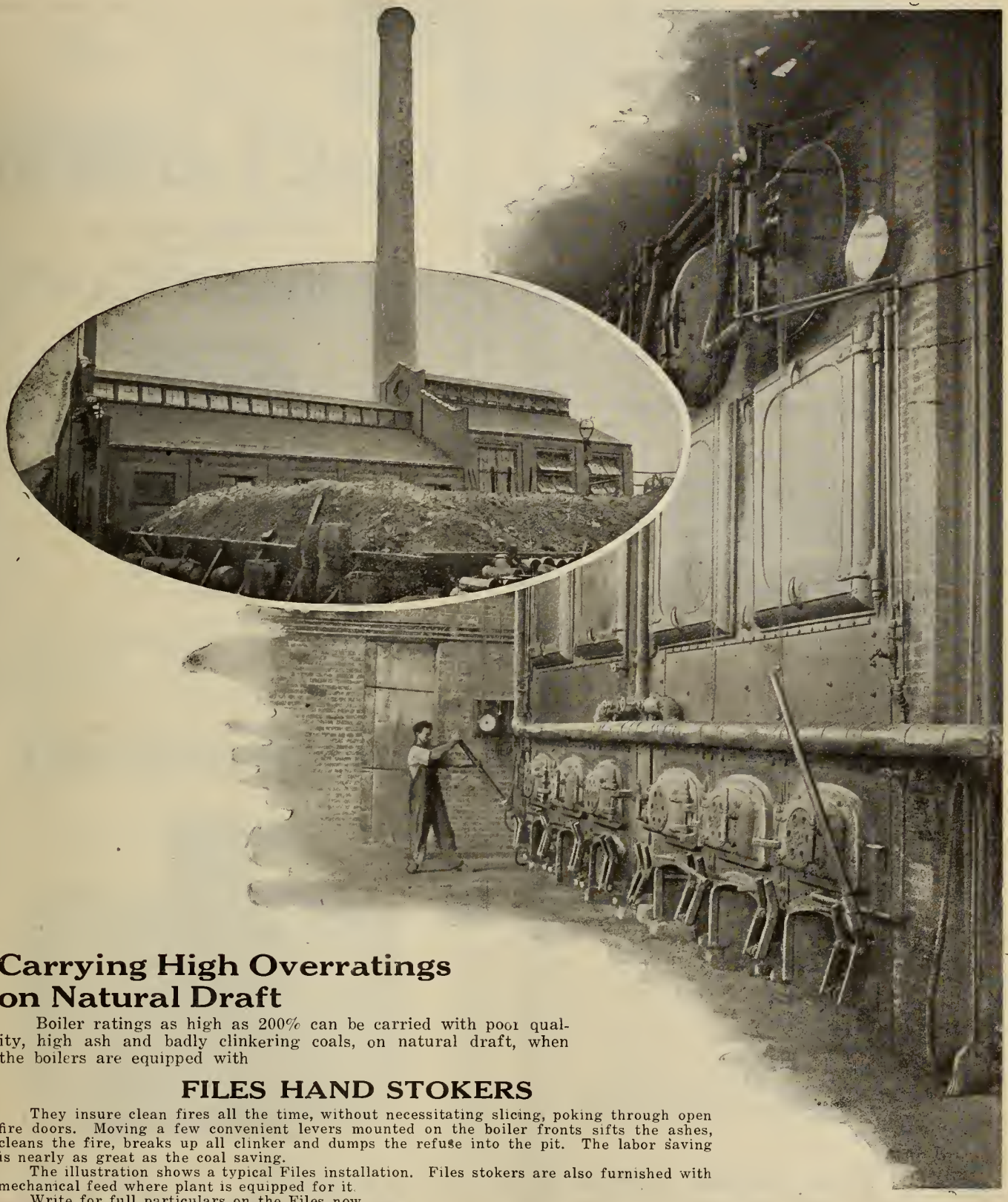

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They insure clean fires all the time, without necessitating slicing, poking through open fire doors. Moving a few convenient levers mounted on the boiler fronts sifts the ashes, cleans the fire, breaks up all clinker and dumps the refuse into the pit. The labor saving is nearly as great as the coal saving.

The illustration shows a typical Files installation. Files stokers are also furnished with mechanical feed where plant is equipped for it.

Write for full particulars on the Files now.

Waterous

BRANTFORD, ONTARIO, CANADA

Close Regulation

of Steam-Driven Boiler Feed Pumps

Hand control of steam-driven turbine pumps is not successful. The turbine needs a constant load for efficient operation. A sensitive, AUTOMATIC control is the only reliable way to maintain a constant load.

FISHER

Excess Pressure Governor

(Type 4)

is designed to render this accurate, automatic control.

It will maintain a fixed or over-pressure in feed lines regardless of variation in steam pressure. It will do so under all conditions either on the ordinary plunger or steam-driven turbine type of boiler-feed pump. It will work satisfactorily whether supplying one or a battery of boilers.

It is recommended for use in conjunction with automatic feed water regulators.

The valve body is of our standard type of construction; the control is of the diaphragm actuated type.

Valve and seat rings are cast from our special formula, hard phosphor bronze which resists corrosion and wire-drawing.

Write for Bulletin No. 101. It contains full information about the Fisher Excess Pressure Governor and other Fisher Pump Governors.

The Fisher Governor Company

926 Fisher Ave., Marshalltown, Iowa

Agencies in all principal cities.

FISHER

TRADE MARK REGISTERED

A pipe joint that's made with a

DART UNION

will never loosen up

IT SIMPLY CAN'T

When the ends of the union are drawn together you have a joint that will never leak because they are both seated with BRONZE (a metal that will not rust or corrode—will not deteriorate.)

You'll have no difficulty in connecting pipes that are out of line. The Bell-shaped Seats allow an easy and perfect connection so long as the union nut can be started on its thread.

This Tee fitting is specially designed to eliminate unnec[illegible]ts. It can be used in close quarters and saves a number of fittings. It combines all Dart Union features. It is heavy and like Dart Unions will not stretch. Made with male or female ends.

We Make Them--Your Jobber Sells Them

DART UNION CO. LIMITED

TORONTO - - ONTARIO

PUMPS

Pumping Devices similiar to this were, until recently, in occasional use in this country.

Centuries before the Christian Era, the inventive Chinaman had developed a rather efficient pumping device. A bullock turned the wheel. Wooden pegs on the rim of this wheel meshed with the smaller wheel on the long shaft. A heavy chain, equipped with buckets, descended into the well and drew forth the water which was carried to the gardens and fields.

All things considered, this was a fairly efficient device. Modern American-Marsh Pumps are **wholly** efficient. They can always be depended upon for reliable, effective, powerful service.

Write for Bulletins.

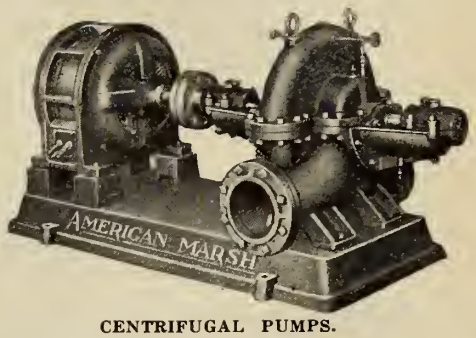
AMERICAN STEAM PUMP COMPANY

Battle Creek, Mich.

Chicago Office:
1220 Monadnock Block

New York Office
17 Battery Place

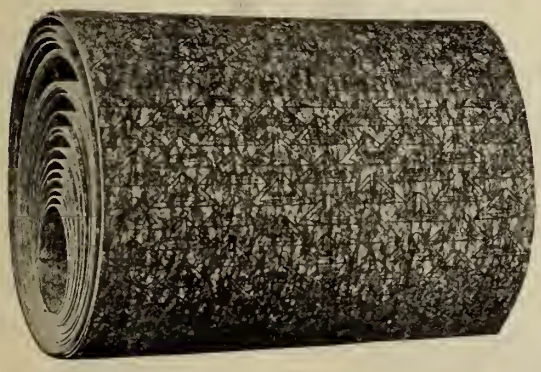
The American-Marsh line also includes Centrifugal Pumps, Power Pumps, Air Compressors, Vacuum Pumps, Condensers, Deep Well Engines.



CENTRIFUGAL PUMPS.

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA
TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

In thicknesses of 1-64 1-32, 1-16, 3-32, 1-8

Let us send you a trial order.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

New Truths and Old Fallacies

HIGH SPEED

Upon a babbitt metal's self-lubricating quality also depends its ability to stand up under high speeds because of the increased rubbing surface and liability to metallic contact.

Where speed and high pressure are combined, a bearing is tested to its maximum capacity, as was the case in the test of Magnolia Versus Genuine Babbitt, by Doctor Torrey.

This Magnolia quality fits it peculiarly for use on high-speed, heavy-duty machinery, such as planers, shapers and other woodworking machinery sometimes running at speeds as high as 5,000 R. P. M. Three to five years in this service is common, and in one case reported to us, the bearings have been running fifteen years and were then still going in good shape.

On light running bearings there is probably no speed limit to the capacity of Magnolia.

Professor John Goodman, before mentioned, says of Magnolia, in this connection: "Under heavy pressures and high speeds, I find that it is very materially superior to any other metal on the market that I have tested, and under such conditions the friction is much lower and above all the metal never seizes."

The frictional co-efficient invariably denotes the extent of a babbitt's self-lubricating quality and it is useless to expect to find that quality combined with a high frictional co-efficient. The co-efficient of friction is the ratio of the force required to produce motion. It is also defined as being the ratio obtained by dividing the entire force of friction by the normal pressure.

(Continued Next Month)

For copy of complete article:
"New Truths and Old Fallacies"
Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.
OF CANADA, LIMITED
Office and Factory:
Montreal: 37-39 Shannon St.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices:
HALL MACHINERY CO., Sherbrooke, Que.,
and Birks Bldg., Montreal

A Good Boiler

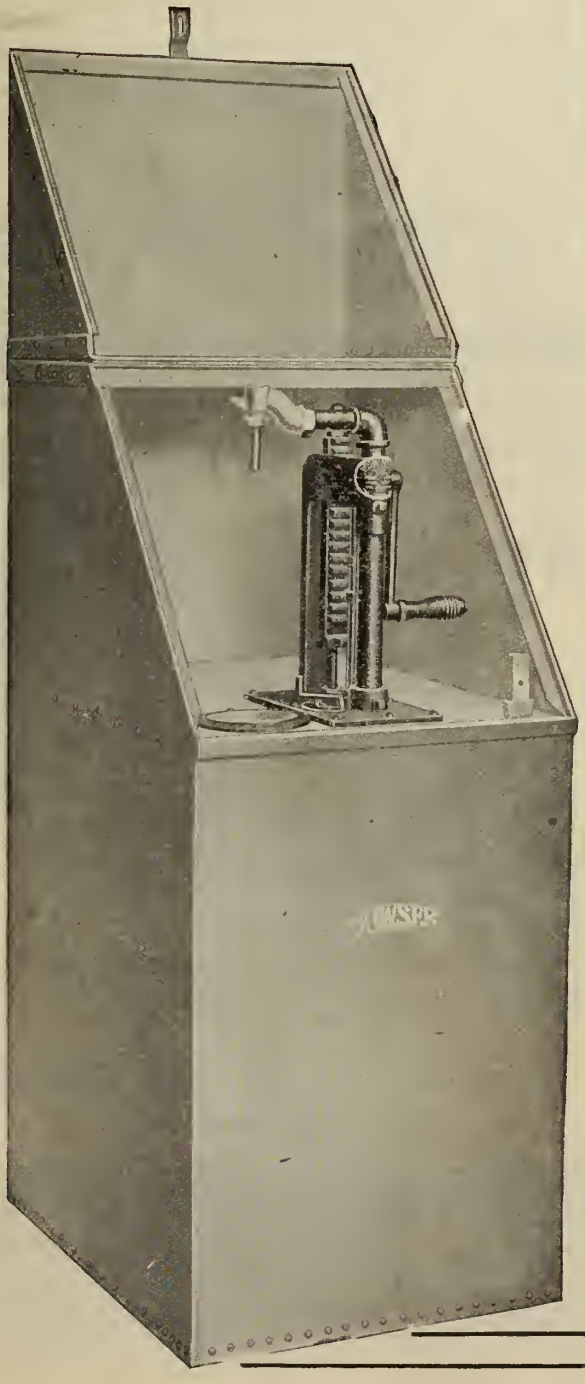
Will make its economy and efficiency very quickly felt. With our Boiler prices where they are today it does not pay to put up with out-of-date, worn out Boilers. Let us quote you surprisingly low figures. Delivery service excellent now.

We build Boilers for Power and Heating uses, in all types, all sizes.

Get Better Lubrication at Less Cost

Install Bowser Oil Handling Equipment

Incorrect lubrication will take its toll of your machinery slowly but surely. Undue depreciation is bound to result from the friction caused by gritty oil. And no matter how good the oil you buy, you cannot have correct lubrication unless it is *kept clean.*



By storing oil in Bowser leak-proof and dust proof Tanks, you will keep *your* oil clean and give better lubrication to your machinery. The Piston-Type Pumps deliver exactly the amount required directly into the distributing container, eliminating waste. Bowser centralizes your oil storage, making it easily accessible. The safety of Bowser is also an important element to consider.

Not once in 35 years has Bowser Equipment started or contributed to a fire.

Whatever your requirements, there is a Bowser to meet them. Ask us.

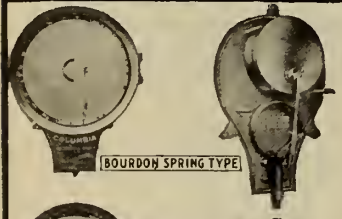
Write for Illustrated Booklet C-21

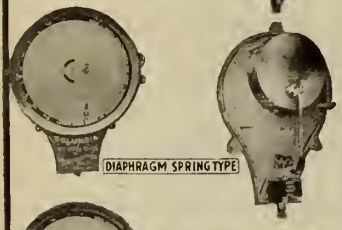
BOWSER EQUIPMENT
is
MADE IN CANADA
y

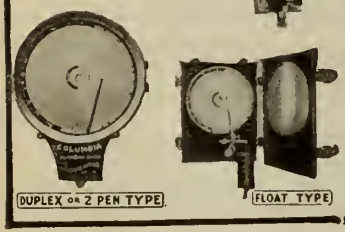
S. F. Bowser Co. Ltd.

2168 Fraser Ave., Toronto, Ont.

"Columbia" Recording Gauges







S. & B. Gauges and Thermometers combine the craftsmanship of veteran gauge makers. In the manufacture of these famous specialties there isn't a man who doesn't realize he is carrying out the traditions of a great institution. The preservation of human life—exemption from property loss and low gauge costs is the triple economy they give you.

"Columbia" Thermometer.

You Can Now Purchase Them in Toronto

CANADIAN users and prospective users of S. & B. Equipment will be glad to know that our Toronto Office is to be stocked with a generous supply of standard instruments. The increasing demand for our products in Canada has made the opening of a Canadian supply house an absolute necessity. To all interested we will be pleased to give full information regarding Technical Data, Prices, Deliveries, etc.

THE Schaeffer & Budenberg MFG. CO.

Brooklyn, N. Y.

Makers of Columbia Recording Thermometers and Gauges with TIME PUNCH

67-69 Frederick St., Toronto

'Phone Main 2578

CO. LTD.

PLIBRICO SAVES COAL

Replaces fire bricks for all purposes. (front door arches, side walls, bridge walls, baffles etc.) Large mills using for complete replacements before cold weather.

AMBEST

Flexible Metallic Packing

Is a perfect packing for a rod that is true and in line. There is no limit to the temperature it will stand, or to the pressure, high or low.

Stocked at various points in Western Provinces.

BEVERIDGE SUPPLY CO., LIMITED

628-630 St. Paul St. West, Montreal

Accurate and Speedy!

The most accurate valve made loses much of its value if it is slow and time wasting in operation.

Thus of great importance is the fact that Homestead Quarter Turn Valves can be opened and closed with the simple motion of a quarter turn. Always in perfect balance opening and closing. And Homesteads are positive acting too. They are tight and stay tight under pressures up to 5,000 lbs. Use them for air, steam, water, gas or heavy gritty fluids.

Made in Straightway, Three-way and Four-way patterns. Built for long, constant service. Write for catalogue!

Homestead Valve Mfg. Company

Homestead, Pa.

HOMESTEAD Quarter-Turn Valves

The Proof of the Pudding

You know the rest. And the proof of the value of a

PLIBRICO JOINTLESS FURNACE LINING

setting is in the **service** it gives.

Hundreds of satisfied users of PLIBRICO attest to its money, time and fuel saving qualities.

Give it a trial in **one** boiler—front arch, back arch, baffles, side walls, or bridge walls—and we believe you will join the throng of PLIBRICO users.

Ask for our book L-41 on "Modern Furnace Building."

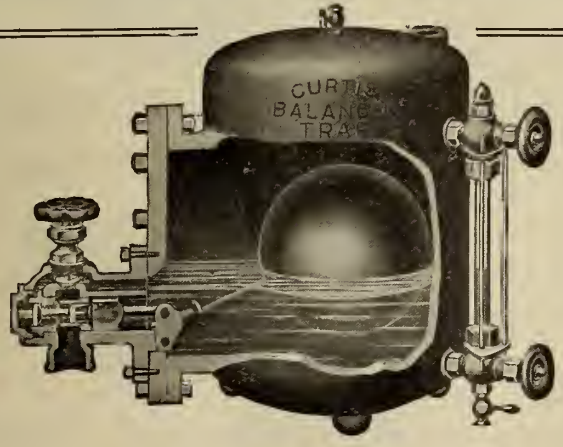
PLIBRICO *is delivered only in steel containers of distinctive appearance as shown below.* Warehouse stocks in all principal cities.

DISTRIBUTORS:

Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans, Coleman & Evans, Vancouver B.C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman, Clancey & Grindley, Calgary, Alta.

1142 Clay St., Chicago, Ill.

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

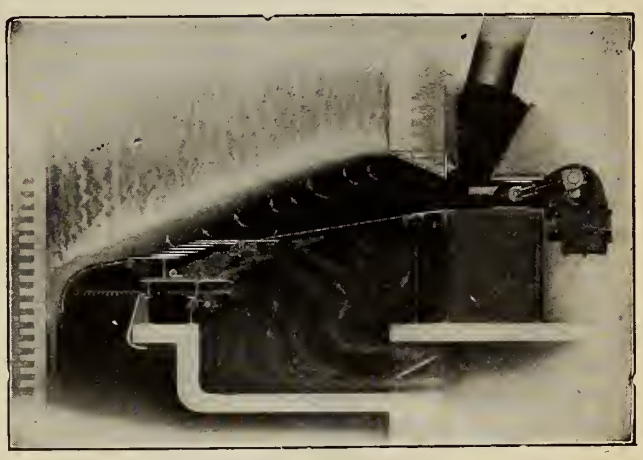
Write for our No. 50 Catalog of Curtis Engineering Specialties. Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: { 180 Washington St., New York City. 318 West Washington St., Chicago, Ill.

High Efficiency and Capacity



Riley Stokers at the McKeesport Tin Plate Company are carrying daily an average load ranging from 230% to 265% of boiler rating. Here 8-retort stokers are installed under 606 H. P. boilers.

CO2 readings indicate the efficiency being obtained. Taken at five minute intervals over a period of thirty days these have averaged slightly over 14 per cent.

The Riley moving grates are a big factor in obtaining efficiency and capacity for:

1. They keep the fuel bed always active and even.
2. The shearing action of each line of grates slices any large clinkers that may form and pushes them to the dump, thereby keeping the fuel bed clean.

To learn more of exclusive Riley features ask for Catalog HR-11.

For information on Murphy Automatic Furnaces for small boilers, see Sept. 20 advertisement, or send for Murphy Furnace Catalog HM-10.

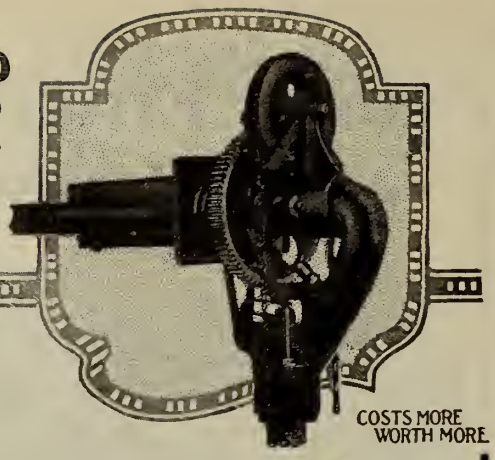
TRADE MARK Rx REGISTERED

Sanford Riley Stoker Co.

Worcester, Mass.

TRADE MARK Rx REGISTERED

DIAMOND
VALV-IN-HEAD
SOOT BLOWERS



DOLLAR FOR DOLLAR!! *POINT FOR* POINT!!

Dollar for dollar the Valv-in-Head soot blower is a tremendously better investments than the independent valve soot blower.

AMONG THE VALV-IN-HEAD ECONOMIES ARE:

1. **Steam for Operation:** Saving of 50 per cent.
2. **Labor for Operation:** Saving of 50 per cent.
3. **Pipe, Valves and Fittings:** Saving of 66-2-3 per cent.
4. **Maintenance:** Saving of 25 to 50 per cent.

These savings alone offset any extra first cost of the Valv-in-Head system. Once installed, the new blowers pay for themselves several times over each year.

Now note some of the outstanding mechanical advantages:

5. **Valve Design**—time of opening and closing exactly adjusted to soot blower operating conditions being slower than the standard quick-opening valve and faster than the standard globe valve, thus solving a problem of long standing.
6. **Valve Body**—heavier and stronger than that of high grade valves for equal pressures and temperatures.
7. **Tightness**—unless operator makes two trips, to close globe valve, one to shut off line (while valve is hot,) and second to tighten valve (after it has cooled and contracted,) the globe valve tends to leak as wire drawing and erosion take place. With Valv-in-Head system, valve is tightly closed at all times. Fewer joints and fittings with Valv-in-Head system mean fewer opportunities for leaky lines.
8. **Control**—steam may be intermittently discharged over two or more arcs in revolution. Arc or arcs of steam jets within boiler invariably cover exact predetermined limits. Speed at which blower element may be revolved is so controlled by reduction gearing as to make improper operation impossible, owing to the fact that there is an audible signal to indicate valve open.

There are dozens of other mechanical points. Why not let us tell you about them.

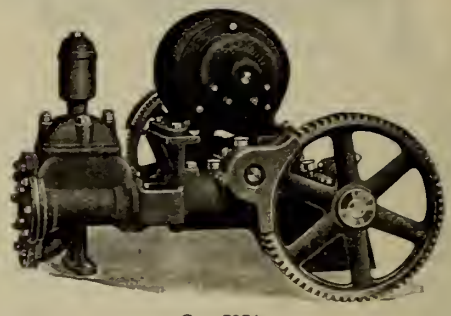
Every boiler needs a mechanical soot blower and you will save money by buying the best. Diamond Valv-in-Head blowers are adapted to all types of water tube boilers. On request our Service Engineer will go over your existing soot blower installation and advise whether it can profitably be replaced with the Diamond Valv-in-Head system.

Ask for Your Copy of Bulletin 287 Describing the New Blower.

DIAMOND SPECIALTY COMPANY
WINDSOR, - ONTARIO

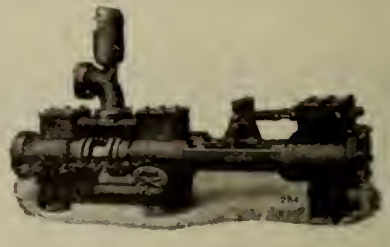
Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN



Cut 7374

All parts made to gauge and interchangeable. Give us opportunity to figure on your pumping requirements.



Cut 7284

BOILER FEED AND GENERAL SERVICE PUMPS

Direct Acting Steam Pumps

For All Conditions of Service and for All Industrial and Public Utility Purposes.

Cut 7242

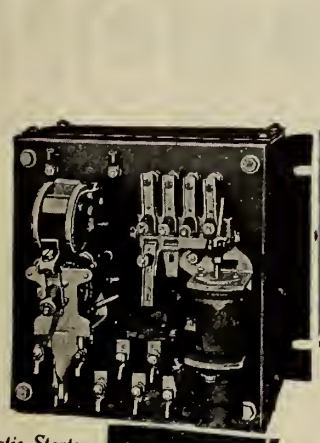
STEAM DRIVEN OUTSIDE PACKED PLUNGER PUMPS

A full line of patterns in belted or direct connected power pumps.

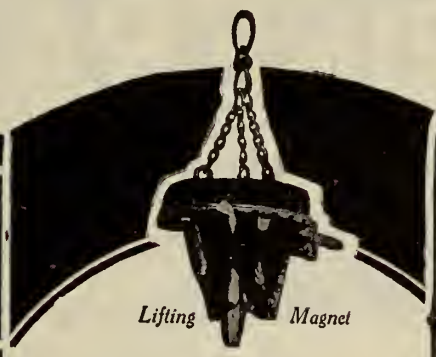
Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

CUTLER-HAMMER



Automatic Starter



Lifting Magnet

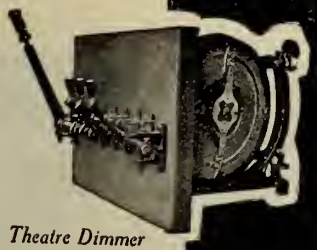
Compensator

Magnet and Control Devices

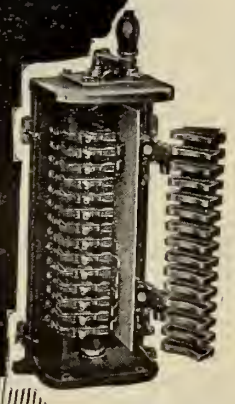
¶ Cutler-Hammer Lifting Magnets and Magnetic Separators have proved of exceptional value in the mining field, in steel mills and in many other industries for lifting and separating metals. The Magnetic Clutch and electrically operated Brake, used primarily in steel and rubber mills and for crane control repectively, are widely applicable to many industries where the gradual engagement or adequate braking of a load is desirable.

¶ In electric controlling devices of all kinds Cutler-Hammer is the recognized standard of dependability, whether for fine speed adjustment of a machine, extremely close voltage regulation, the wonderful light dimming and colour effects in a modern theatre, or the automatic control of heavy loads or other special operations.

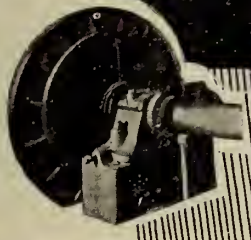
¶ Details and recommendations of suitable Cutler-Hammer apparatus for your control problems are available at our branches.



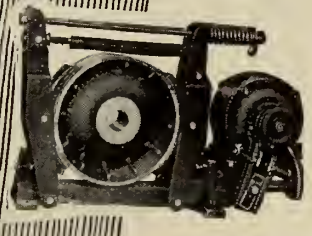
Theatre Dimmer



Drum Controller



Magnetic Clutch



Motor Operated Brake

Magnetic Separator

Northern Electric Company

LIMITED

Montreal Quebec Toronto London Regina Edmonton
Halifax Ottawa Hamilton Windsor Winnipeg Calgary Vancouver

LINDE

Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

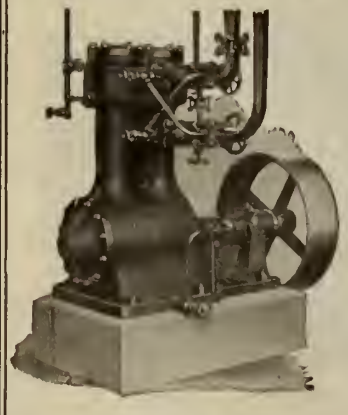
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

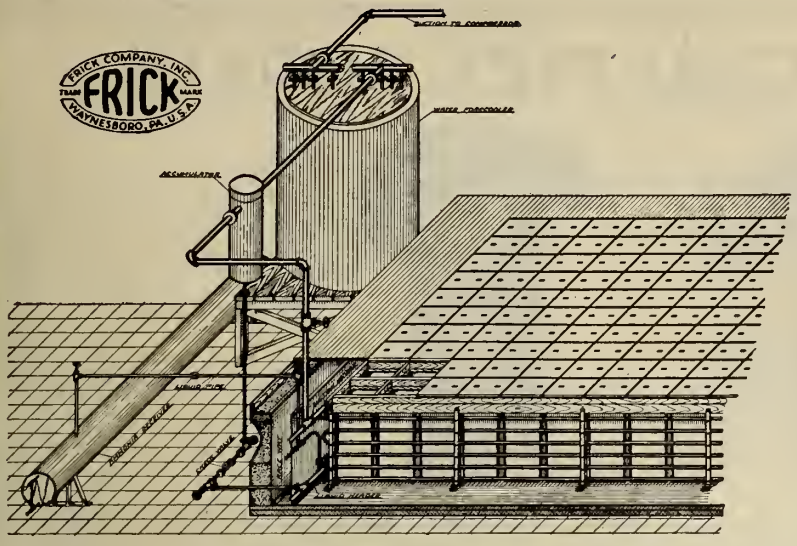
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



The FRICK FLOODED SYSTEM

Is a STANDARD Part of Every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

Simplifies plant operation by reducing the number of feed valves to be regulated.
Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
Adds to plant safety by preventing priming accidents.
Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

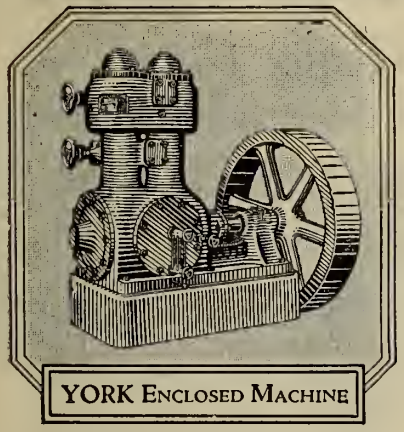
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose —all types: Vertical—Horizontal—Absorption.

Branches in all Principal Cities.
Canadian Representative: FRICK Ice and Refrigeration Co., Montreal.

YORK



RELIABLE REFRIGERATION
For Every Practical Purpose

The governing factor in the selection of Refrigerating Equipment, in most cases, is the reliability of the machine. Can it be absolutely depended upon to perform the work? A shut-down during the warm season is always annoying and often is an item of expense, due to loss of production or deterioration of products in storage.

York Refrigerating Machines have demonstrated their absolute reliability by more than thirty-five years of satisfactory service, which has given them a high reputation throughout the refrigerating field.

Ice and Ice Cream Manufacturers, Meat and Produce Dealers, Creameries, Dairies, Confectioners, Grocers and many other industries are using York Mechanical Refrigeration profitably in the production and marketing of high grade products. If you require Refrigeration in your business, we should be pleased to have you investigate the York System.

Canadian Representative:

CANADIAN ICE MACHINE COMPANY
TORONTO: Villiers and Munition St., Eastern Harbor Terminals.
MONTREAL: .....324 Craig St. West
WINNIPEG: .....85 Lombard St.

YORK MANUFACTURING CO.

(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA., U. S. A.

There is a YORK Plant to fit Your Business

P⊕H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs. the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

For all High Pressure service, and where it is objectionable to reduce the thickness of the wall of the pipe by threading, we recommend P⊕H Lap Joint.

Made in Canada by

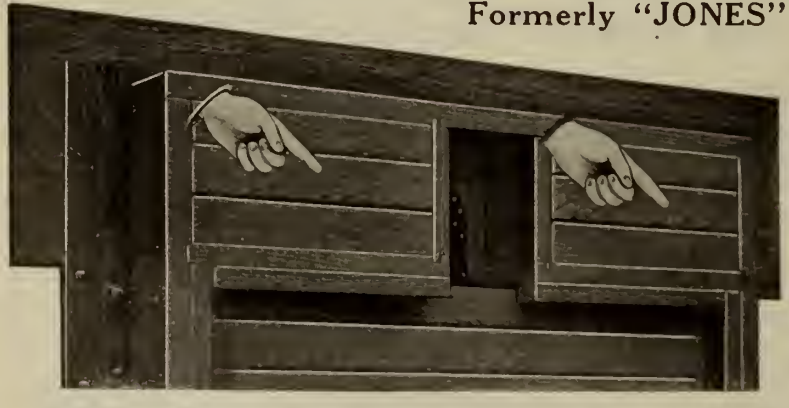
PAGE-HERSEY TUBES, LIMITED

100 CHURCH STREET, TORONTO, ONT.

Incomparable JAMISON

Formerly "JONES"

Heavy Duty Cold Storage Doors



Have Many Points of Superior Construction

Note the back of our Standard Track Head Frame with track part; we insulate and finish our track frame heads, an unusual feature. Then note the simplicity of the Track Lift device over the door; no springs or other delicate parts to get out of order. Our Automatic Self-tightening Fastener draws the door rigidly tight each time it is slammed. The hinges too are three to five times heavier than other makes.

These features, and many others, are fully explained in catalog No. 10. Write for it.

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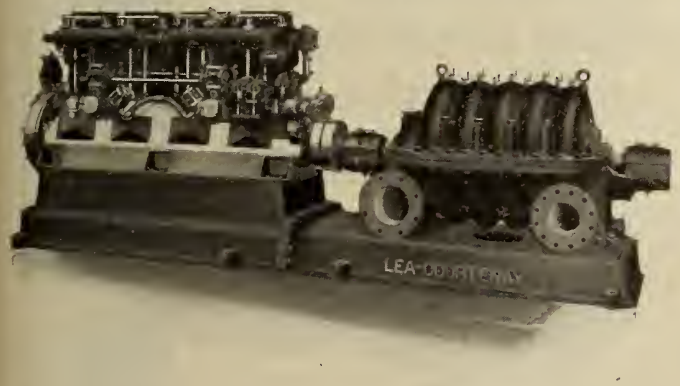
For emergency a Sterling THE ENGINE of REFINEMENT driven pump

For the finest boats that float



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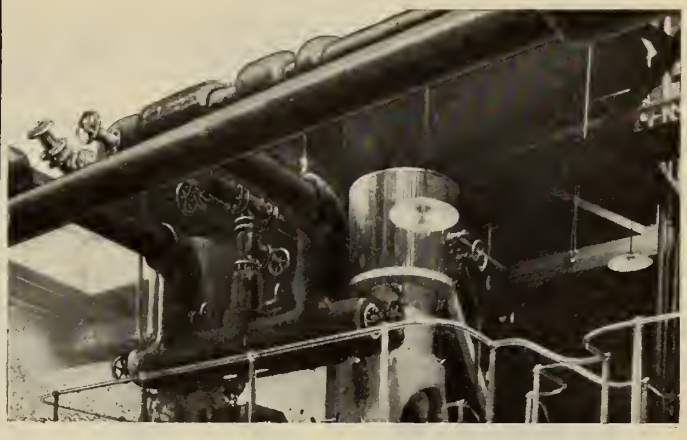

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The loss of refrigeration from uninsulated lines is so great that the saving effected by applying Nonpareil Cork Covering will pay for their insulation in a year or less—an annual return of 100% that can be depended upon for years to come.

Not only does Nonpareil Cork Covering afford the maximum protection but, given reasonable care, it will retain its insulating value indefinitely. Protected, internally by its binder of natural gum, and externally by its ironed-on mineral rubber finish, Nonpareil Cork Covering is impervious to moisture. Hence, it is proof against any deterioration in efficiency or structural strength. It "lasts longer than the pipe."

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For Cold Lines, Coolers and Tanks.

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One of them—a tremendous help in reducing boiler-room losses—is the Vulcan Soot Cleaner. It reduces stack temperature, increases steam capacity and production, and decreases fuel consumption.

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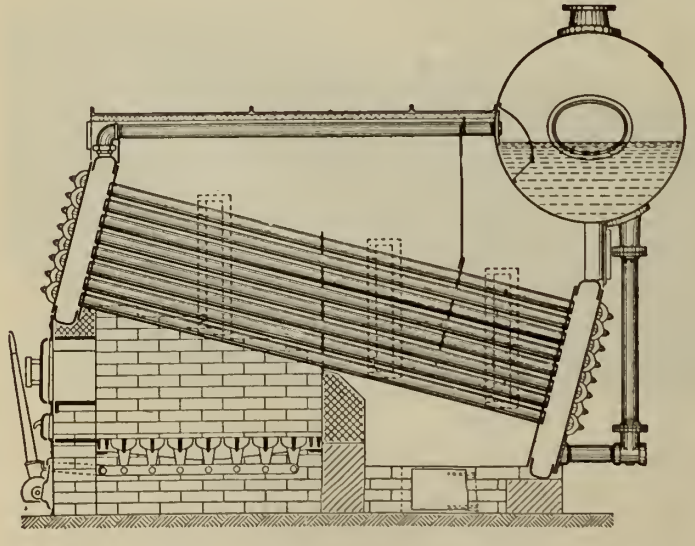
The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

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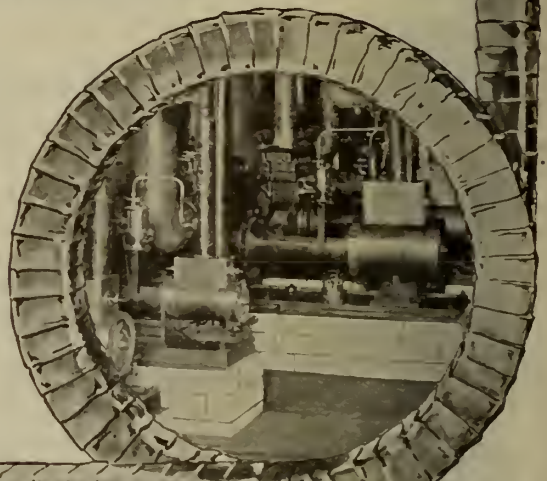
Eight years ago Chief Engineer, N. Gross, of the Standard Oil Building, Chicago, installed JOHN CRANE Flexible Metallic Packing in the boiler-feed pump pictured below. Mr. Gross reports packing and pump in good order after eight years and has standarized JOHN CRANE on all service.

JOHN CRANE holds this long service record because of its scientific, practical construction. . Made of babbitt foil and graphite, it brings Packing science "The Babbitt-bearing Principle," and while responding to the slightest pressure of the gland never dries out, but remains compressible and will not score rods.



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The Annual Directory Number of

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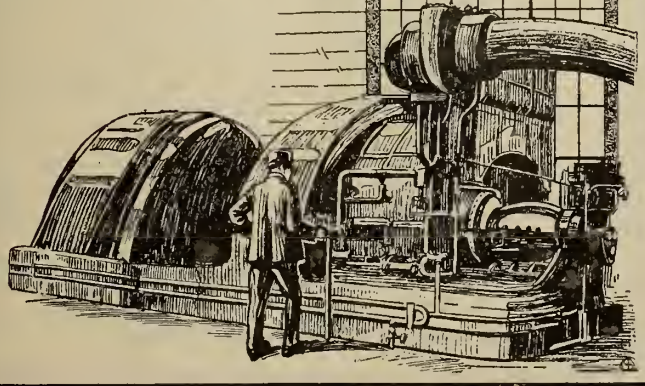
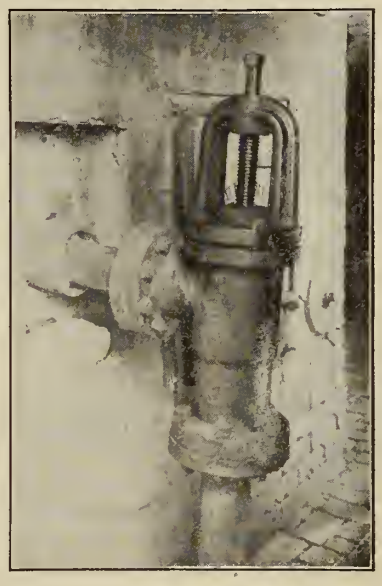


10 Years' Daily Blow-off Service Without Repacking



The illustration—made from an unretouched photograph—shows a 3-inch angle flanged YARWAY SEATLESS BLOW-OFF VALVE in the plant of the Consumers' Power Company, Cadillac, Mich.

This valve was installed in 1911, has been in continuous daily service ever since, and has never been repacked.

The engineer says it looks good for ten more years.

Do you experiment—or do you buy blow-off valves of proved worth?

Many power plants now use Yarway Seatless and Yarway Double Tightening Valves in tandem, where two valves are required on each blow-off line.

YARWAY

(formerly the Simplex)

Seatless Blow-off Valve

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Representatives in all Principal Cities

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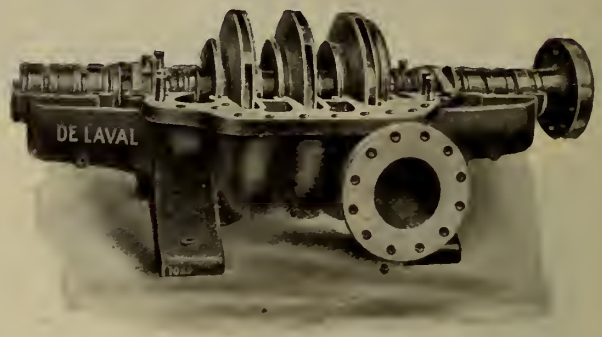
YARWAY POWER PLANT DEVICES

Centrifugal Pump Perfection

Like perfection in any of the many difficult arts which look easy to the outsider, perfection in the building of centrifugal pumps is compounded of an accumulation of exact knowledge and long and extended experience.

The unequalled efficiencies obtained by De Laval centrifugal pumps (one recently showed over 86% under official test) have been attained only through consistent experimenting and testing. De Laval centrifugal pumps are carefully tested as to capacity, efficiency and running qualities, and it is thus possible for our Engineering Department to note the effects of every change in design.



De Laval multi-stage pump with casing cover removed.

High efficiency is further effected by the use of De Laval labyrinth wearing rings, which reduce to a minimum the leakage from the discharge to the suction chamber.

Every De Laval centrifugal pump is fully guaranteed. If you will state the proposed conditions of operation, our engineers will promptly give you the benefit of suggestions based upon an extensive experience, and will quote results which we are prepared to guarantee.

Ask for our new Centrifugal Pump Catalog B.

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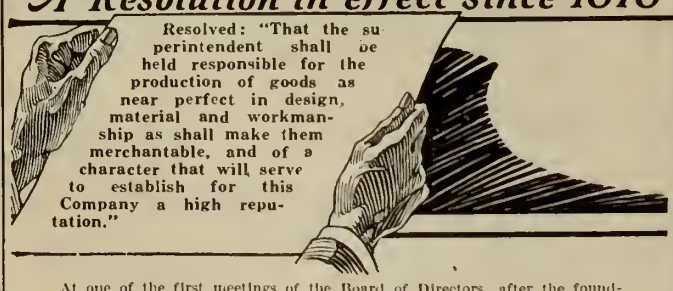
A Resolution in effect since 1878



Resolved: "That the superintendent shall be held responsible for the production of goods as near perfect in design, material and workmanship as shall make them merchantable, and of a character that will serve to establish for this Company a high reputation."

At one of the first meetings of the Board of Directors, after the founding of the Pratt & Cady Co. in 1878, the above resolution was passed. The spirit of this resolution has guided the manufacture and policy of the Company through the more than forty years that have passed since its adoption.

The test of every valve that leaves our factory is our final check that we have accomplished our aim in its manufacture, that is, sent to our customers a valve that will do the work for which it is designed through an unusually long term of years.

PRATT & CADY VALVES MUST STAND THE TEST

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Betson Plastic Fire Brick Co., Inc.

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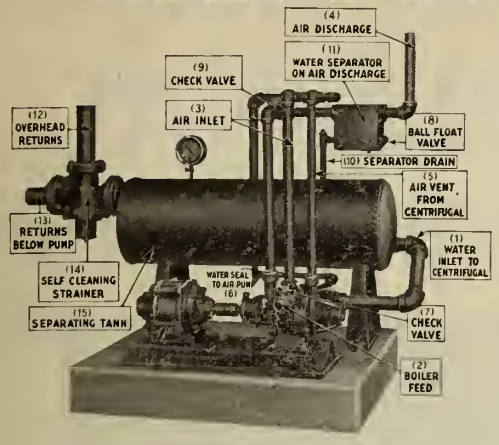

Referring to Fig. 3, the heating returns, air and water,, pass through the self-cleaning strainer (14) into the separating tank (15). The water falls to the bottom of the tank (15) and passes into the centrifugal through the pipe (1), driving out the air through the pipe (5). As soon as the centrifugal is full of water it begins to pump and forces the condensation into the boiler through the pipe (2), emptying the tank (15). The centrifugal now stops pumping because it cannot handle air, the check valve (7) preventing a back flow. The power required to drive the centrifugal is closely proportional to the quantity of water handled. It takes almost no power when it is not pumping.

The air is rapidly exhausted from the system by the air unit, which is connected to the top of the tank 15 by the pipe 3. The small amount of water necessary to keep the air end primed is obtained from the bottom of the separating tank 15 by means of the pipe 6. This water is discharged with the air and is thrown to the bottom of the separator 11 and automatically returned to the tank 15 through the pipe 10, the ball float valve 8 preventing any air from re-entering the system.

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HYTOR VACUUM HEATING PUMP

FOR return line heating systems, dryer exhaust systems in paper mills, or other vacuum work where large percentages of liquids have to be handled with gas.

The **Jennings** is recommended to all discriminating users of equipment, as it is unsurpassed in design, economy and efficiency in operation.

Study the principle of its operation here, then send to us for complete description.

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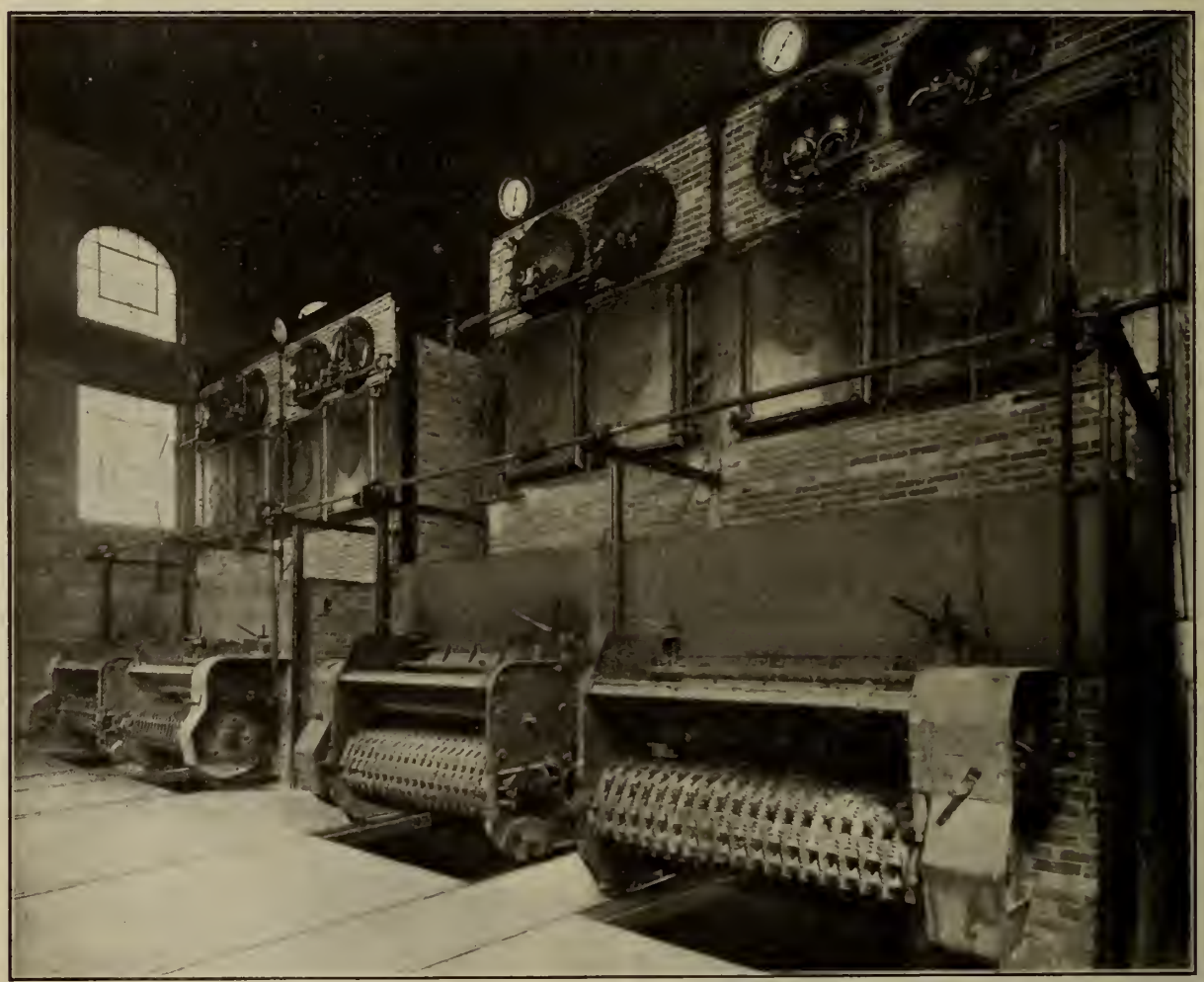

Illustrating Four G. & McC. Sectional Water Tube Boilers at the Plant of The Weyburn Mental Asylum, Weyburn, Sask.

G. & McC. Co. Engines, Boilers, Heaters, Pumps, etc., in your Power Plant assures you of a steady, reliable and efficient service.

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Treatment of Boiler Feed Water

In This Article, Which is the Third on this Subject, the Author Considers the Artificial Zeolite Systems, and the Evaporating Methods. He also Gives Figures, Illustrating the Investment Side Of the Question

By ROBERT JUNE

OUR PRECEDING articles have dealt with the various impurities in boiler feed water, the resultant operating troubles, and we have also considered the use of boiler compounds, boiler metal treatment and water softening plants, as a means of overcoming our difficulties. Several important methods of water treatment have yet to be considered.

The Zeolite Water Softening Method

All of the troublesome calcium and magnesium in boiler feed water may be removed by passing the water through a bed zeolite. Zeolites are silicates which possess the valuable property of effecting a rapid exchange of the sodium, which they contain, for calcium and magnesium in the water. As hard water comes in contact with zeolites this exchange takes place instantaneously, harmless sodium salts being formed and the hardness remaining in the zeolite. The action is a chemical exchange, and takes place in the cold. There is of course a definite limit to the quantity of sodium which may be exchanged for calcium and magnesium in the water, this limit depending upon the total amount of exchangeable sodium in the zeolites, which is regulated by the sizes of the zeolite bed.

When the limit of exchange has been reached, the zeolite bed is regenerated by passing through it a brine composed of common salt. As the reverse of the softening exchange takes place, sodium replaces the absorbed hardness and the hardness forming constituents are carried off to the sewer as a clear solution. The zeolite bed is then ready to treat another batch of hard water. As the exchange involves no loss of the zeolite, the same bed may be used for an indefinite number of years without the addition of a new supply of zeolite.

The use of zeolites for softening water for industrial and domestic purposes was introduced in the United States about ten years ago by the Permutit Company, who use the trade name Permutit in marketing their various products.

The design of any particular zeolite system will of course depend upon the chemical composition of the water to be treated and the maximum hourly and total daily amounts. The area and depth of the zeolite bed must therefore be determined in each individual case after the water has been analyzed and the desired capacities determined. Many other factors are also involved as zeolite equipment is frequently installed in combination with other apparatus such as iron removal apparatus, aerators, lime-soda pre-treatment apparatus, etc., depending upon the amount and variety of impurities that it is desired to remove from the water, and other operating conditions.

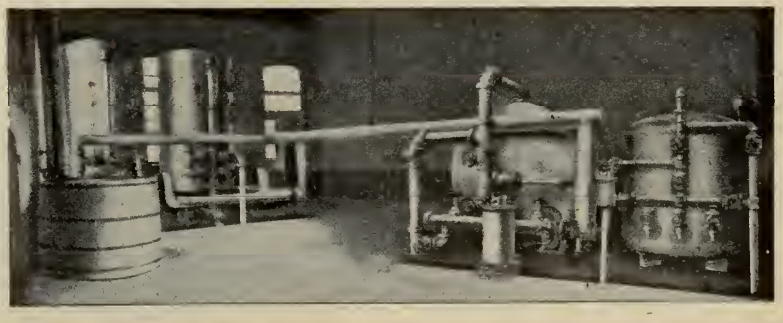
In the main, however, satisfactory operation is obtained through the use of a zeolite water softener alone. The rate of softening through zeolite bed is normally about the same as through a rapid sand filter, and in the case of fairly soft waters it may have as much as double this rate, for the reason the equipment takes up a comparatively small amount of floor space in proportion to the quantity of water handled.

In the design of this equipment the water is passed through the zeolite bed. Operating valves are provided so that during the process of cleaning and regeneration the flow may be reversed, thus thoroughly loosening and carrying off all sediment that has been deposited in the zeolite bed during the process of softening as well as the calcium and magnesium impurities that are removed by the regeneration process. These impurities are all discharged to the sewer and by reversing the flow in this manner any tendency to form channels in the zeolite bed is removed.

When continuous night and day supply of water is desired it can be accomplished either by arranging for storage of the softened water or by means of the two zeolite softeners in parallel that permits the regeneration of one while the other is softening water.

The regeneration is accomplished by introducing into the water softener a brine solution that contains exchangeable sodium in excess of the amount of calcium and magnesium that is to be removed from the zeolite bed. This solution percolates hrough the zeolite bed forcing out the calcium and magnesium to the sewer and continuing until all particles of zeoli e have been regenerated. The length of time required for regeneration is governed by operating requirements as it may be accomplished in twenty to thirty minutes, or over a period of six hours or more.

If a single zeolite softener unit is operating on a ten hour day it can be most advantageously regenerated by occupying the idle time over night as it is obvious that the more slowly a zeolite bed is regenerated, the more completely this function will be performed. If there are two softeners in operation working



The 200,000-gallon Permutit Water Softening and Clarifying System of a Manufacturer in Rensselaer, New York, Which Operates on a Four-Grain Water From the Hudson River.

alternately the period for regeneration is best arranged to occupy the full softening period of the unit that is in operation. For other operating conditions, other periods of regeneration may be most suitable, it being kept in mind that the longest periods of regeneration give the best results.

Because of its positive character and its flexible adaptability to all operating conditions, zeolite water softener offers a real solution to feed water problems. Boilers and auxiliary apparatus fed with zeolite softened water are found to be maintained permanently clean. Zeolite water softening apparatus because of its simplicity and automatic features has a the cheapest commodity existing, its cost for regeneration purposes is equally low per thousand gallons of water softened. It has been shown that a return of 50% on the investment may be expected from the average zeolite water softening installation for boiler feed purposes and there are many recorded instances of installations in textile mills, paper mills, laundries, soft drink manufacturies, canning factories, etc., in which the softened water is used for manufacturing processes, that investments in zeolite equipment have made a return of several hundred percent. For this reason and because of the large amount of capital that is necessarily tied up in boilers and auxiliary equipment it may be seen that the consideration of zeolite water softening apparatus may prove to be a very profitable move on the part of the manufacturer.

Zeolite Plants from an Investment Standpoint

The figures in Table 1. have been tabulated for a small steam plant operating three 200 H.P. boilers, average load 500 B.H.P peak load 750 B.H.P. Make up amounts to 50 per cent of the total boiler feed. This data is from average figures based on the experience of Borromite users.

TABLE 1

(Coal at $5.00 per ton in the firebox)

Cost of Operation with Scale.

(1)—Make-up water is 12 grains per gallon in hardness. Scale in 3 weeks is 7-64 in. thick—average about 1-16 in.; loss in heat is 10 per cent. Boilers opened for cleaning and inspection every 3 weeks	
(2)—One of the 3-200 H.P. Boilers is cleaned each week. Labor cost—2 men, 2 days at $5 per day, per annum	$1040.00
(3)—Coal for heating the water drained out of boiler and that to fill boiler after cleaning—1-4 tons x 52 weeks x $5.13 tons;, per annum	65.00
(4)—Investment in a Boiler and Stoker, $5000. Since a boiler is out of service 2 days each time it is cleaned, this means with 3 boilers there are 104 days one is out of use in a year ($5000 x 7 per cent x 104) ÷ 365 = interest loss on investment	99.00
(5)—Excess blow-down over normal, to eliminate sludge from use of boiler compound, and hard water is 2 gauges extra per day or 310 gallons total for three boilers. (310 gal x 8.3 lb x 210 degrees [rise in temperature] x 365 days x $5.00) divided by (8400 (B.T.U. per lb of coal; x 2000 lb;—	58.70
(6)—New tubes, 12 per boiler or 36 at $10.00 per annum	360.00
(7)—Coal, 1400 tons at $5.00 per annum	7000.00
Total	$8622.70

SUMMARY:

Cost of operation with scale	$8622.70	
Cost of Scale-less operation	$6416.50	
Gross annual saving		$2206.20
Cost of Borromite Softener for plant of this size—$3000.00		
Interest and depreciation at 15 per cent	450.00	
Cost of operation, 26 tons salt at $10.00	260.00	710.00

TABLE 1

(Coal at $5.00 per ton in the firebox)

Cost of Scale Less Operation with a Borromite Water Softener

(1)—Make-up water is 0 grains per gallon in hardness. No scale is formed. Boilers opened for inspection once every 12 weeks	
(2)—No scale, no labor cost for cleaning..per annum	$0000.00
(3)—Coal for heating the water drained out of boiler and that to fill after inspection 1-4 ton x 12 months x $5.00 (3 tons) per annum	15.00
(4)—Investment in a Boiler and Stoker $5000. Since a boiler is out of service one day each time it is inspected, this means with three boilers there are 12 days one is out of use in a year, ($5000 x 7 per cent x 12) ÷ 365 = interest loss on investment	11.50
(5)—No excess blow-down with clean soft water	00.00
(6)—New tubes, 3 per boiler or 9 at $10.00 per annum	90.00
(7)—Coal 1400 tons—10 per cent (140 tons) or 1260 at $5.00	6300.00
Total	$6416.50

SUMMARY (Continued)

Gross annual saving	$2206.20
Less interest and operating charges	710.00
Annual "Pay-Balance," Net	$1496.20
Return on investment in Softener	50 per cent

Distilling Plants and Evaporators

Distilled water for boiler feed is in successful use in many power plants. It is first produced by vaporizing the raw water in an evaporator, and then passing the steam to a condenser, or preferably into the boiler feed heater, where it is condensed by means of the feed water entering from the main power plant condenser.

The Reilly Submerged Type Evaporator, consists, essentially, of a closed shell for holding the raw water, into which are introduced a number of steam coils. Live steam from the boiler, sometimes at reduced pressure, or auxiliary exhaust steam, is passed into the coils where, upon condensation, it gives up its latent heat to the raw water, thus vaporizing the raw water.

In order to effect greater economies in operation "double effect" distilling plants are frequently used. In this type of plant steam from the "first effect" evaporator is condensed in the heating coils of the "second effect" evaporator, the vapor from the "second effect" evaporator being condensed in the usual way.

As a matter of general practice it will be found that the production of the "single effect" distilling plant is approximately one pound of distilled water for one and two-tenths pounds of steam supplied to the evaporator coils, whereas the "double effect" distilling plant will produce about one pound for each seven-tenths pounds of steam supplied to the "first effect" evaporator coils.

Therefore, in choosing between the "single effect" evaporator and the "double or multiple effect" evaporator, consideration must be given to these facts.

As a matter of general practice it will be found that the production of the "single effect" distilling plant is approximately one pound of distilled water for one and two-tenths pounds of steam supplied to the evaporator coils, whereas the "double effect" distilling plant will produce about one pound for each seven-tenths pounds of steam supplied to the "first effect" evaporator coils.

Therefore, in choosing between the "single effect" evaporator and the "double or multiple effect" evaporator, consideration is to be given to first cost on the one hand, and to the economies effected by the use of the compound equipment on the other. From a dollars and cents standpoint it is usually more economical and better engineering practice to use the "double" or "multiple effect" system.

Evaporating plants are generally designated as "low heat" level or "high heat" level. In the "low heat" level plant the evaporators may be operated with boiler steam at full or reduced pressure, or with auxiliary exhaust steam at a pressure as low as two pounds. The latter installation, where auxiliary exhaust steam is used, is apt to be quite expensive however, owing to the large volume of steam handled and to the fact that evaporation must take place under a vacuum, thus requiring vacuum pumps, etc.

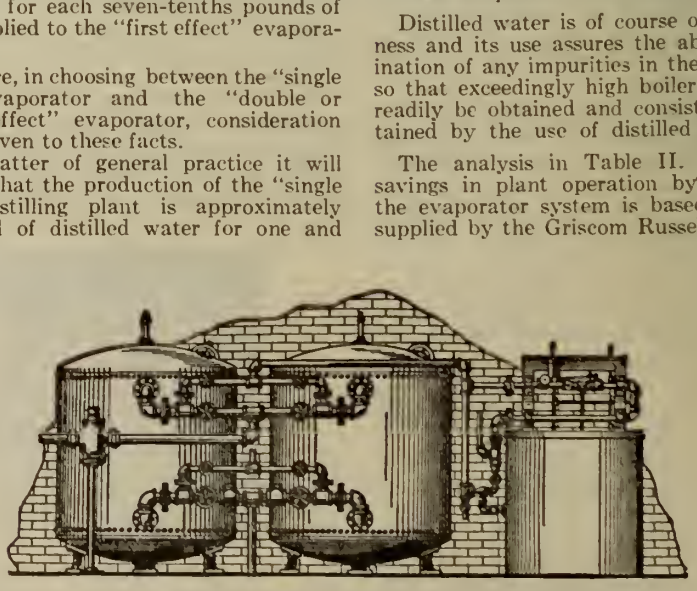
The "low heat" level evaporator is usually preferable where economizers are used, and it may also be a profitable investment where there is considerable auxiliary exhaust steam.

Where there is say 10 per cent or more of make up water required and where economizers are not used, it will generally be found that the "high heat" level evaporating system is the most satisfactory and economical. As the name indicates, evaporation in this system takes place at comparatively high temperatures and pressures. As the steam consequently passes from the evaporator at high temperatures it can be condensed in a condenser, using circulating water at coreespondingly high temperature.

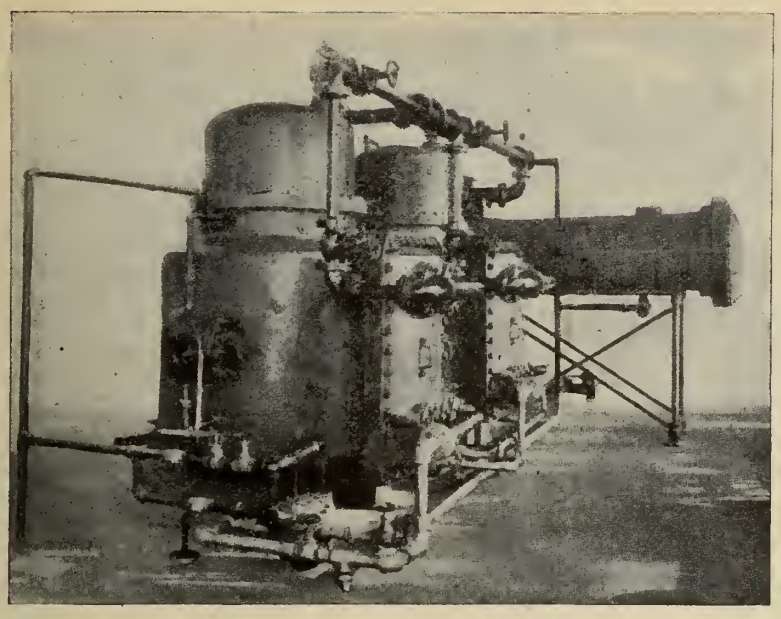
In the Griscom-Russell Company "high heat" level condenser the boiler feed is pumped from the boiler feed heater through the "high heat" level condenser or condensers, on its way to the boilers. Drains from the "high heat" level condenser and from evaporator coils are passed to the boiler feed heater. With this system the boiler feed water reabsorbs all heat given up in the evaporating coils with the exception of the small amount lost in radiation and the evaporator blow off.

Distilled water is of course of zero hardness and its use assures the absolute elimination of any impurities in the feed water, so that exceedingly high boiler ratings can readily be obtained and consistently maintained by the use of distilled feed water.

The analysis in Table II. of probable savings in plant operation by the use of the evaporator system is based on figures supplied by the Griscom Russell Company.



A Borromite 2-Unit 24-hour, Continuous Service Type Softener.



Griscom-Russell High Heat Level Evaporator Plant Simple Two Effect.

TABLE II

Net hourly boiler evaporation . . . . . 150,000 lbs
Net hourly boiler feed make-up. . . . . 15,000 lbs
Net hourly boiler blow (without evaporator system) . . . . . 7,500 lbs
Boiler steam at 200 lbs gauge, saturated
Hot well temperature . . . . . 90 d'g's F
Raw water which would be used for evaporator feed . . . . . 63 degrees F (Brackish)
Auxiliary exhaust steam, 13,600 lbs per hr at 0 lbs g
Boiler evaporation, 9 lbs of steam to 200 lbs g per lb of coal (Useful heat per lb of coal equals 10,513 B T U)
Cost of coal . . . . . $4 00 per 2000 lbs
Cost of present make-up water $1 00 per 1,000 cu ft (Purchased from Public Water Works) . . . 63 degrees;

BOILER BLOW—

Will be practically eliminated
Savings per year—7,500 x 330 x 8,760 x $4 00
10,513 x 2,000 $4,124 00

BOILER TUBE HEAT TRANSFER—

Will be increased sufficiently to save approximately 5 per cent of coal bill
Saving per year—150,000 x 8,760 x 05 x $4 00.
9 x 2,000 $14,600. 00

BOILER TAKE DOWN—

Will be largely eliminated
Estimated saving per year $1,000 00

BOILER MAINTENANCE—

Tube replacements, etc, will be greatly reduced
Estimated saving per year 500 00

COST OF PRESENT MAKE-UP WATER—

Will be eliminated
Saving per year—15,000 x 8,760 x $1 00
62 5 x 1,000 $2,100.
Total yearly savings in plant operation $22,324 00

Charges Against Evaporator System

FIRST COST—

Approximate total cost of Evaporator System including piping, lagging and erection $26,900.00

RADIATION—

Approximate total radiation surface—800 sq ft
Assuming radiation—60 B T U per sq ft per hr
Heat losses per hour—800 x 60—48,000 B T U

EVAPORATOR BLOW—

With the system proposed, evaporator blow will be about 2,500 lbs per hour at 212 degrees F (Temp of raw feed 63 degrees)
Heat losses per hour—2,500 x 149—373,500 B T U
Total heat losses per hour—421,500 B T U
Cost of these losses
per year . . . . 421,500 x 8,760 x $4 00
10,513 x 2000 $703 00
15 per cent per year on $25,900 . . . . . $4,035 00
Yearly labor charges for evaporator sysetm . . 1000.00
Total yearly charges against evaporator system $5,738.00

CONCLUSIONS

Total savings in plant operation per year $22,324.00
Total charges against evaporator system per year 5,738.00
Net yearly balance $16,586.00

COAL STORAGE ECONOMY

That there are no unsolvable technical difficulties in the way of the plan recently suggested by President Harding to the American Mining Congress whereby the production of coal be made more uniform, and conditions of unemployment ameliorated and seasonal periods of depression largely obviated in the mining industry by the provision of storage reservoirs in which coal could be stored in quantity by large consumers and producers, is declared by Dr. H. Foster Bain, Director of the Bureau of Mines. Careful analysis may show an extremely slight loss in the heating value of most bituminous coal after storage for a considerable period, says Dr. Bain. This loss, however, is very much smaller than is commonly supposed by the public, and in burning the coal little or no difference can be distinguished. Certain coals have an extra market value when carefully sized; handling these coals in and out of storage causes some breakage and may lower slightly the market value of particular coals, but this loss in value relates largely to the availability of the coal for certain classes of equipment and for certain uses, rather than to its actual heating value.

Spontaneous combustion in coal, the most troublesome factor in handling large storage piles, can be prevented, if proper methods of storage and supervision are adopted.

"The adoption of a general policy which would provide reservoirs of bituminous coal to be drawn upon in times of great demand or of low production is entirely a commercial question," continues Dr. Bain. "If the producer, or the dealer, or the large consumer, could produce or buy coal in the spring or summer for a price low enough to justify the cost of putting coal in storage and its rehandling, minus a fair insurance rate that would be gauaranteed a continuous supply in time of need, storage would become common."

"This lower seasonable price of coal could be brought about by concessions on the part of the miner, the mine operator, and the railroads. For the sake of obtaining more regular employment, the miner might accept a lower wage or rate in certain seasons of the year, although this is doubtful; but the mine operator might accept less profit during the same periods in order to keep up his production. Steady and regular mine operation at capacity production always means lower production costs, as compared to with intermittent operation and lessened production. Overhead expenses —taxes, interest, management, together with the expense of keeping the mine in proper working condition—all go on, whether production is light or heavy, or has entirely stopped. The railroads could assist by accepting a lower freight rate on coal moved in the spring and summer.

"The small individual consumer, especially in the cities, often has inadequate storage space. Storage at the mine may allow a steady working-day in time of shortage of cars but will not ensure steady seasonal operation. Again, large scale storage at the mines does not do away with the difficulty of transportation often experienced to the points of consumption. Moreover, a great many mines are in a hilly or mountainous country, where but little, if any, space is available for large storage capacities. The proper place, therefore, for storage on a large scale is at or near points of consumption.

"This latter kind of storage involves the use of a large plot of ground, as coal stored 10 feet high allows slightly less than 10,000 tons storage per acre. The purchase and installation of mechanical coal handling devices and systems would also be necessary.

"There are in existence numbers of Americans who have successfully designed and built many coal storage systems for public utilities and other corporations which at present store considerable quantities of coal. In addition, there should be a fuel engineer in charge who has a practical and technical knowledge of the way in which different kinds and sizes of bituminous coal will probably act in storage, and who knows the engineering features vital to the economical handling of coal. These three factors are today easily obtainable in the United States; their purchase and employment involve large capital expenditures on which an adequate return must reasonably be expected.

"When, at such a projected storage plant or yard, coal can be purchased at a delivered price sufficiently low to secure a fair return on the investment, after adding the operating costs of storage and rehandling, then coal storage yards will become established near all of the points of heavy consumption and the present seasonal variations will be largely avoided.

"There are no mysteries or unsolvable technical or mechanical questions that block the way to the adoption of a general policy of storing bituminous coal, in either large or small quantities."

Some Experiences with Hydraulic Accumulator

The Author Relates Some of the Difficulties Encountered When the Hydraulic System is Called on to Supply a Heavy Overload, and the Methods Adopted to Keep the Plant Running

By J. A. McGillivray

A LARGE number of engineers in the Steel Plants of Canada will look back to the period of the War and the time when munition making was at fever heat, with mixed feelings. Many could, if they would, tell of worth-while stunts that they had to pull off at a moment's notice in order to keep the old mill going. Certainly there is none who will give the soldier, "Jack," "Tommy" and "Sam," more credit for the glorious stunts pulled off in the mud of Flanders than the engineer, but there was glory in it for them if nothing more. But the engineer had his Flanders mud in the accumulator pits, packing a rod maybe with the water streaming down his arms and back, trying to keep his footing on greasy timbers, endeavoring to raise into place a gland that weighed 200 or 300 lbs., that wouldn't enter on studs that were forced out of true by the swaying and bumping of accumulators that were carrying pressures of 1500 to 3000 lbs. to the sq. in. supplying pressures and gap-riveters operated by near-madmen who thought of nothing but tonnage. (They were usually paid piece work).

If his Flanders mud wasn't there he might be found wallowing on his belly in it inside of a hot boiler that had to be in the line in the morning, or maybe he was waiting for zero hour (12 midnight when the munition workers took 20 minutes for lunch or to change dies), with a spanner in his hand to go over the top with a blown out gasket or a broken stud in a plunger packing gland. There was damn little thanks for it, let alone glory. But just the same they were days of real sport—eh, Old Timer?

A recent visit to my old hunting ground brought some of those almost forgotten memories back again. Therefore, I will set down a few of the incidents that may interest others who are still having their Flanders mud, and who knows but that some of the old timers who can talk but won't will change their mind and give us a yarn.

During the early Fall of 1914, about the time the late Sir Sam Hughes was making history at Valcartier, Colonel Tom Cantley was making history in the Nova Scotia Steel Mills, experimenting at shell forging and installing hydraulic presses. The hydraulic presses at the Eastern Car Company's plant were being used for experimental purposes and when the first difficulties were overcome, shell forging commenced in earnest at that plant.

There were two presses, one 500 ton and one 250 ton, R. D. Wood Vertical Hydraulic Presses, and one Laidlaw Dunn Gordon Comp. Engine driven hydraulic pump that could more than supply the presses and other equipment when working on ordinary car work, but when forging shells it was quickly found that the pump was not going to fill the bill easily. The press operations were becoming quicker as the munition makers became more expert and a general improvement in the treatment of steel used for punches and dies enabled them to turn out more work without changing.

One morning the master mechanic came into the Power House and sized up the situation thus. "Mac, we've got to bolster this thing up some way. There are two new presses on the way here now."

"Oh, goodnight," I thought, "the accumulator is hitting the blocks now."

I told him I'd overhaul the water end Sunday. I did so and found the valves in good order. It was the same thing Monday. All the pump could do. At times when both presses operated together they would bring the accumulator to the bottom and the pressure would fall to zero—the pump going for all it was worth—when the press operator closed the operating valve the pressure built up instantly to 1500 lbs. per sq. in. with a shock that would almost carry the lines away.

"Well," I thought, "if the pump can stand up to this kind of work it is better than any machine I ever saw," and at short notice another pump was out of the question.

The speed of the pump was 55R.P.M., this speed being determined by the flyball governor, "belt driven." I took up the matter of increasing the speed to 72 R.P.M. with the master mechanic next day. After arguing that the whole system would be wrecked before a new pump could be had, I finally got his consent and had a new pulley made and put on. Well, we got 72 R.P.M. all right.

Hitting A Snag

This is what happened. Everything started away O.K. and the engine was doing nicely. I felt pretty good over the stunt just pulled off, but when I happened to look around the accumulator was up at the blow holes on the rod and the engine going full speed. Before I got to the throttle the accumulator was bounding up and down at the top of the rod like a trip hammer, the pressure gauge showing 4000 llbs. every surge of the accumulator and back to zero. Out at the press the operator let the operating lever go and beat it for his life, leaving the shell press thrashing up and down until it was almost wrecked before I had the pump shut off. Half a dozen men came running in to see what happened, some of them heard on the way in that the boilers exploded and others thought it was a German bomb explosion. Anyway when we saw who they were I postponed explanations and solemnly assured them that the whole thing was caused by an accumulation of air in the top of the accumulator. That it was O. K. now. They went away marvelling at our ability to handle such a serious situation in so short a time and passed the word that "there was air in the accumulator, but Mac's got it straightened out."

It was early and the Master Mechanic had not arrived so I put a man at the throttle for the time being. When the Master Mechanic came in I told him what happened. Now he was a man that when you were in trouble was right with you to the limit until it was over and lecture afterwards. What did happen was that the inertia of the heavy flywheels at 72 R. P. M. with what steam was between the chrometer valve and the engine and what was in the receiver carried the engine forward after the accumulator had closed the chrometer valve until it had uncovered the ports again by overtravelling, thus admitting fresh steam and forcing the accumulator up to the blow holes in the rod at a pretty good clip. The inertia of the weight carrying the accumulator past a number of the holes thus relieving all the pressure on the line for an instant. The weight of 150 tons was, you might say, suspended in mid air, then falling back onto the column of water compressed the air in the top of the cylinder and at the same time compressed all the spring shock absorbers on the line. The combined reaction of the shock absorbers, the expansion of the air at the top of the cylinders and the discharge from the pump driving the accumulator up again above the blow holes. This was repeated with the regularlity of steam hammer until the throttle was shut off.

How It Was Remedied

Before another day passed we devised a slotted link that would allow the inertia of the engine to be spent before the accumulator pulled the valve across the seat, the slot being made long enough as may be seen from the sketch. The cable was made fast to a turn buckle so that the length could be adjusted as the cable stretched. When the valve is open the pressure on both sides is balanced and a spring keeps the lever up to the forward end of the slot. As soon as the ports in the valve are closed the pressure is all on the back or inlet side and the unbalancing causes the valve to remain stationary while the

spring allows the link to be carried forward. When the accumulator comes down, the backweight opens the chrometer valve and allows the pump to start up.

Part of the unbalanced pressure on the valve is carried on an adjusting stud so that the valve won't bear too heavy on the seat. This stud used to make contact with the valve stem and the constant motion used to wear it quite rapidly as there was not much chance to oil it. This meant that with the accumulator at the top of the rod and the presses standing at the valve stem shortened by contraction, due to steam being shut off, the engine would allow the valve to seat so firmly that a 60 lb. weight would not open it when the presses started again. It was usual to watch it at such times and give the weight a kick away, but it sometimes happened that the accumulator would be down before it would be noticed. One day my assistant noticed that the valve was stuck. He ran over and grabbed the rope at X (see sketch) and gave a pull, with the result that his hand was drawn into the sheave and he lost three fingers.

Then I cudgelled my brain for an idea. Two electricians were doing a repair job shortly afterwards and were making a fibre plug. As I watched them I decided where a fibre plug would be a good thing and as far as I know that fibre plug is there now. It is inserted between the adjusting stud and the valve stem. Now the new presses were installed and we were up against it again, for capacity. We had been using one accumulator and keeping the other all ready packed for a standby, during those strenuous days a set of packing would last about 72 hours as a rule (and it was some job to pack the rod, especially if the accumulator did not set level after letting it down). So now we had to put both in the line as this gave increased accumulator capacity and so sensitive were they that if the packing was tighter on one than the other we had to balance them by throwing scrap iron from one to the other.

Emergency Tools

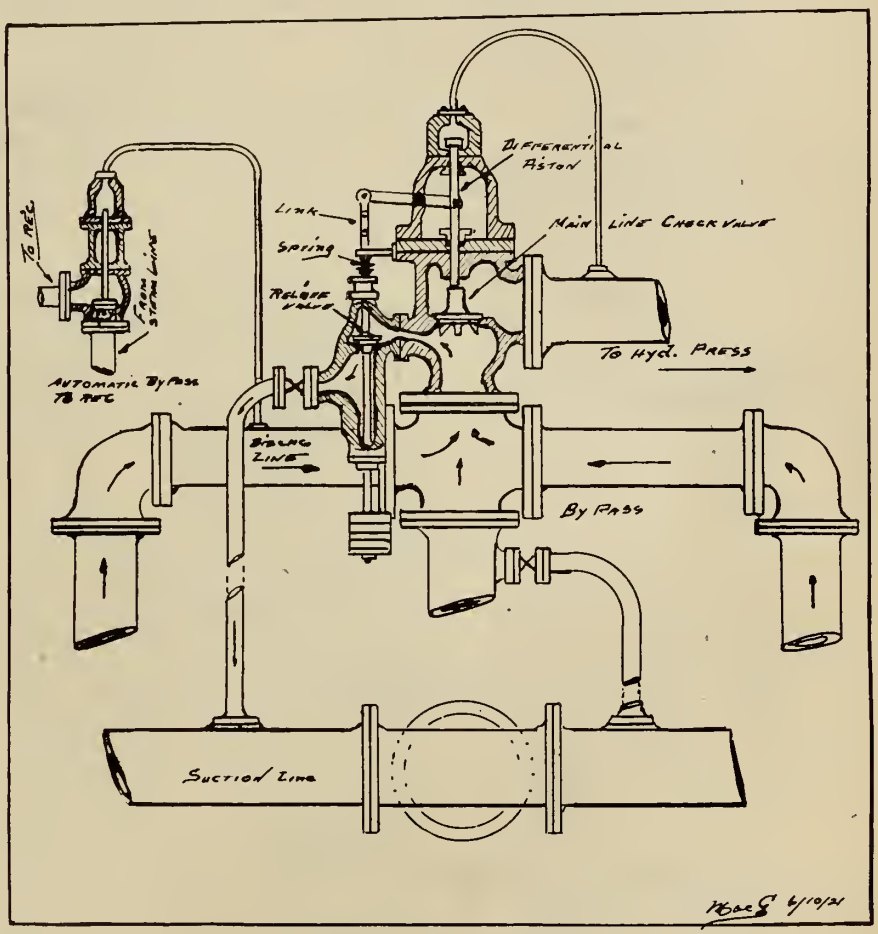
About this time the valves in the water end were getting bad. Formerly we used to reseat and regrind the valves between car orders, having anywhere from two weeks to two months in which to do the work. We used to do the work by hand, grinding the valve into a seat, but now all the time we could expect was from 11 o'clock Saturday night to 6 a.m. Sunday morning and we had 42 valves and seats in bad condition and no spares. So one week end we had a draftsman make a drawing of a valve and seat and by the next Saturday we had a cutter made that could be used with an air motor and a socket for grinding by motor. We commenced at 6 A. M. Sunday morning and at 9.30 P. M. we had 42 valves fitted and all the covers on but the last one. A test that night showed a displacement efficiency of 96½%, which was good when you consider that we rushed the job and that the pressure pumped against on the test was 1500 lbs. per sq. in. See sketch for tools used with air motor for reseating and regrinding. For regrinding we used a light air motor.

Once when two of the studs in the plunger stuffing box broke causing the gland to be broken in three pieces and tearing the plunger, so badly that it was ruined, we simply dropped a blank gasket into a flanged connection on the suction of the crippled plunger, cleared the broken gland and cut the damaged neck ring clear and started up with two plungers working again, after a shut down of 17 minutes. Of course the press foreman logged two hours delay against hydraulic pump, but he didn't know that the general manager happened to be on the scene as well as the master mechanic. The time was about 2.30 P. M. If it had been 2.30 A. M. Mr. Foreman would have got away with it. However five minutes delay at the power house might easily under some circumstances cause two hours delay at the forging presses unless there was a warning given before closing down. Of course when an accident happened there was no chance for a warning.

In those days the general managers worked side by side with the men during the early stages when shell forging was yet in a somewhat experimental stage—everybody worked (but the engineer). We had strict orders to challenge anybody except a company official found inside of the premises and to ask to see their pass. If they had none or refused to produce one, "Call a Cop."

The execution of this order called for a certain amount of judgment and diplomacy, since it was difficult to know who was an official and who was not, as officials did not always go about with white collars, shaven chins and manicured finger nails, and instead of being in bed the night before they may have been in the mill all night trying out some new punch or die or furnace and would look somewhat disreputable to a stranger. So we got in wrong once in a while.

An amusing incident occurred about this time. One day I was busy (A strange thing for the engineer to be busy), when I looked up from my work. I saw two men standing in the middle of the floor taking stock and discussing the equipment. One of them did not look too bad but the other was to say the least, disreputable looking, but I could see at the first glance that he was no fool. It was more than mere curiosity that brought him in. There was something uncommon about him, "looked like a dangerous cuss." That was the way we sized him up. (If he should read this he will smile.) They were duly challenged and could produce no passes and



Hydraulic regulator for by-pass.

seemed rather unwilling to give satisfactory answers. After explaining that Col. Cantley's orders were that visitors should have a pass or leave the premises they were not inclined to go I started for the telephone when they explained who they were and produced satisfactory evidence. I found to my utter astonishment that the disreputable looking fellow was the son of Col. Cantley and was assistant to his father, as well as Superintendent of shell forging in the steel works and one of the smartest mechanics in Eastern Canada.

I found out a little later that same day that he had been on the job for 36 hours without sleep or rest and had dropped into our plant to compare notes. His father was President and General Manager of both concerns.

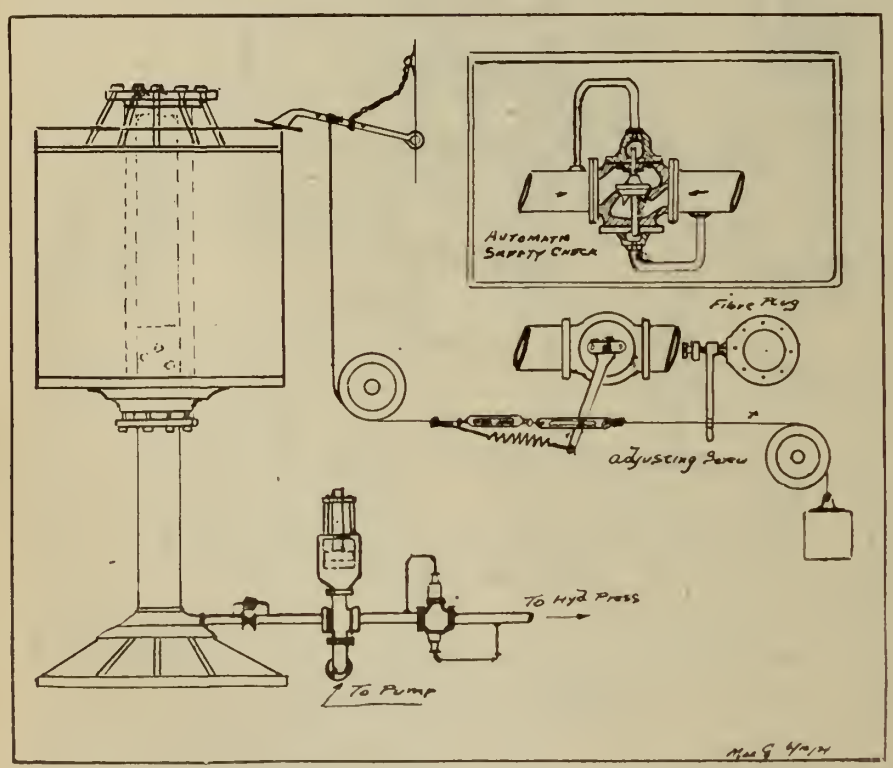
A Serious Accident

It was Sunday evening at 5.30 P. M. that one of the most serious accidents occurred. During the period I speak of shell forging activities were at their height. We were supplying two 250 ton C. P. R. Hyd. presses, one 250 ton and one 500 ton R. D. Wood presses with one 400 gal. pump and using two accumulators. There was nothing to spare, we were short of power at best so everything had to be in the best of order to carry on through the week. Sunday was repair day. It was the custom after the pump was packed and the accumulators packed and all the leaks on the system were attended to, press operating valve leathers renewed and pump valves overhauled, to test the system. After the test the accumulator was pumped to the top of the rod, the pump was stopped and if the system as a whole was tight the accumulator stayed up, if there were leaks the accumulator would creep down, then there would be a hunt for the leak, with a view to repairs. This day we found everything O. K. The accumulator was at the top and staying there, the men beat it for home. I filled my pipe to have a comfortable smoke while waiting for the night engineer, feeling that we were in luck to get through so early. I was facing the accumulator when I saw it start for the bottom like a falling stone. There was a crunch of timbers and a crash of bursting metal when it struck the bottom. (A weight of 150 tons falling 18 feet will do some damage to itself when it strikes solid bottom).

The accumulator when resting sits on oak timbers built up from the foundation 10" x 10" oak laid on top of each other to a height of 5 ft. The weight went through the oak as if was match wood. The rod was driven out through the cap, the pipe lines cut off and gland and stuffing box smashed, in fact the whole thing was wrecked.

What happened was that a length of double ex-heavy hyd. pipe in the pipe tunnel split for its entire length, releasing the water. The Master Mechanic rushed out a gang of pipe fitters, had the lines repaired and we were operating at 12 P. M. that night with one accumulator. It was a costly repair job and if we had had both accumulators up at the time of the accident we would have lost them.

The Master Mechanic came in one day and says "Mac. what's to prevent that happening again?" "Nothing" says I. But that set me thinking. By night I had an idea. We both got at it with the result that we patented the safety check valve shown here. Moreover we developed the idea until we succeeded in patenting a triple duty valve (not shown).



Throttling arrangement on hydraulic pump.

The valve is kept in open position by having an area in contact with the line side greatly in excess of that on the accumulator side to prevent slamming, should the pressure on the pump or accumulator side fall off greatly such as would be caused by a broken line the accumulator pressure will force the check valve to its seat. So that there won't be too much of a shock when the check seats there are holes drilled in the valve to allow a small amount of water to pass through and let the accumulator down slowly.

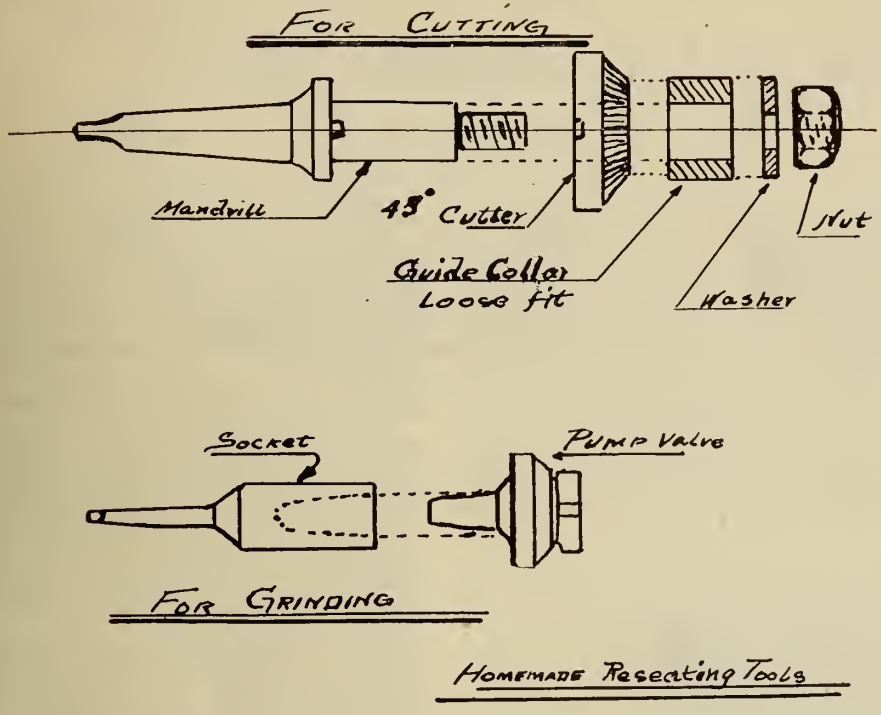
The relief on this pump is very interesting and requires very little explanation. When starting up, the bypass is opened up but when the pump is in operation on ordinary classes of work there will be many times when the presses or hyd. riveters are not using water. The pump will be stopped and the accumulator weight will maintain the line pressure at 1500 or whatever normal pressure may be. This means that if there is no relief valve the pump must start against line pressure (This the pump won't do if the Engine is stopped on a weak point, say with the H. P. steam adm. valve hooked off or when just over the centre without the aid of a steam bypass. This condition is taken care of by an automatic bypass described later). So the idea of a relief valve is to allow the pump to keep in constant motion at a slow rate of speed without coming to a dead stop.

Operation of the relief valve is as follows. When the pump is checked by the closing of the chrometer valve the main line check valve seats. The line pressure acting on the top of the differential piston forces it down following the check valve. This movement opens the relief valve. The pump will then pump through the relief to the suction.

When the pump speeds up for work all the volume of water pumped cannot pass through the relief valve but forces the main check from its seat and forcing the differential piston to its highest position, allowing the relief valve to be closed by the weight. Then all the water goes through the main check to the lines.

Automatic Steam Bypass to Receiver.

When the pumping engine is for any reason standing there is no water pressure on the pump side of the main line check. Should the steam adm. valve on the H. P. be unhooked the chrometer valve would not admit steam to the receiver and the low pressure cylinders so a bypass was connected into the receiver, being opened when the chrometer valve opened by the steam acting underneath the disc. and when the pump started up the bypass valve was closed by hydraulic pressure from the pump side of the main check. Thus the pump would start from any position, being automat-



Home made tools used for reseating and regrinding hydraulic pump valves. With the above outfit and two spare cutters, 42 valves and seats were cut and ground in 12 hours actual working time. A test showed the water end efficiency to be 96½%. Slight gland leakage not measured.

ically bypassed both steam and water ends would normally be kept moving slowly when the presses were idle, preventing an accumulation of condensation and excessive strains set up by expansion and contraction.

Besides the hydraulic system we had the air compressors, boilers, stokers, turbines and generators to look after, any one of which was necessary to shell making.

In this connection I might mention a stunt pulled off by the electrical engineer.One evening, as we had only one exciter available at the time just as if the devil himself was conspiring to throw us down, the exciter went on the blink.

The electrical engineer was called in for consultation. It looked bad, for a time. There was an old D. C. line coming in from the steel works that had been there from construction days. The voltage at the steel plant was 220, but owing to the line being small it would not serve 25% of the D. C. required at the car plant and anyhow we had to have A. C. to operate at all. After locking himself up in the office for ten minutes he had a plan and inside of half an hour we were operating. This is what he did.

The line drop was considerably over the old D. C. line (this was favorable) so he disconnected the A. C. field resistance from the idle generator and put two A. C. field resistance in series on the one generator, put a man at the A. C. rheostat to regulate the voltage as required. The result was that we were able to operate (with a somewhat fluctuating voltage) until the necessary repairs were made.

INVESTIGATION OF COAL GAS

As the result of a study of the formation of tar emulsions in water-gas sets, made under a co-operative agreement of the United States Bureau of Mines, the University of Illinois, and the Illinois Geological Survey, at Urbana, Illinois. it has been proved that tar emulsions could be largely prevented by proper manipulation. A method was developed for determining rapidly the percentage of water in tar emulsions. A full report of the results of these experiments and the methods of preventing emulsions in operation is being published by the University of Illinois Experiment Station at Urbana, Ill.

The results of a series of experiments conducted for the Bureau of Mines by W. W. Odell, illuminating gas engineer, at Davenport, Iowa, indicate that mixtures of some mid-western coals and coke give satisfactory service as fuel in water-gas sets in substitution for the high-grade eastern coke generally used in that section. By the use of such mixtures a considerable saving in cost may be effected without introducing any serious difficulties in the process of manufacture. A report on these tests will be published as a technical paper of the Bureau of Mines.

On the transfer of Mr. Odell to other duties, the study of the use of central district fuels in water-gas sets was continued for the Bureau of Mines by W. A. Dunkley. Mr. Dunkley conducted experiments in the 11-foot water-gas sets of the Coal Products Manufacturing Company, at Joliet, Illinois, with coal from the No. 2 bed mined at Murphysboro, Illinois. Many difficulties encountered in using coal have been gradually overcome. A report of these experiments is in preparation. Mr. Dunkley devised a test for comparing the activities of iron oxide for gas purification. This test has been tried out by seven gas laboratories, and substantial agreement in results with six standard samples of oxide has been obtained.

A series of tests on the effects of using steam in steaming horizontal gas retorts has been made by the Bureau of Mines, in co-operation with the Illinois State Geological Survey, at Mendota, Illinois, with coals from the Elkhorn district of Kentucky and from Franklin County, Ill. With a coking time of 6 to 8 hours, approximately 5 per cent. more heating value in the gas per pound of coal was obtained.

At the Pittsburgh, Pa., experiment station of the Bureau of Mines, investigations relating to the purification of city gas are being continued in co-operation with the purification committee of the American Gas Association. A. C. Fieldner, chairman of the committee, and Superintendent of the Pittsburgh Experiment Station, is in general charge of the work. At this station, A. R. Powell and G. S. Scott are working on the development of improved methods for determining the efficiency of iron oxides for gas purification. A bibliography on gas purification is in preparation.

At the Pittsburgh Experiment Station, co-operative work has been conducted with the Bureau of Standards relative to the quantity of carbon monoxide produced when natural gas is burned in house-heating appliances under different burner adjustments. Carbon monoxide is formed in appreciable quantities if a burner is not carefully regulated as to the height of the pan above the burner, the quantity of primary air added, and the design of the burner

An investigation has been conducted at Pittsburgh by the Bureau of Mines to determine the quantity of nitrogen produced when gases are analyzed by the slow-combustion and the explosion methods. The tests indicate that negligible amounts are produced by the slow-combustion method when properly conducted and none by the explosion method when air is used as the oxygen supply, although appreciable quantities are formed when mixtures of air and oxygen are used.

CATALOGUES

Chas. Cory & Sons, New York, have taken over the manufacturing and selling of the Royer Flow Indicators from the A. H. Sloan Company Inc. of Detroit, Michigan. The catalogue Bulletin 5-B describes a number of types of these indicating flow meters, designed for a wide variety of service. The Pitot tube is the basis of the design of all these meters, the construction being modified to suit the different services.

The Value of Intercooling Air

By C. K. Bennett*

COMMERCIAL air compressors are water cooled either by injecting water into the compressor cylinders, water-jacketing the cylinders, or by compressing the air in two or more stages and cooling the air between cylinders by means of water-jacket vessels known as intercoolers. Two of these methods are generally used together on the same compressor.

Water injection has never been extensively adopted in this country inasmuch as its use is limited by several disadvantages. The water feeding devices demand constant attention. The air becomes saturated with water vapor and this moisture increases cylinder and piston wear, and later frequently gives trouble by freezing when air is expanded in doing work.

Jacketing the cylinders is simpler than either of the other cooling methods. However, it is less efficient. Since the period of compression is short and therefore only a small percentage of the total volume of compressed air, delivered at each stroke, can come into contact with the water cooled cylinder, the cooling effect is small.

For these reasons, modern practice is to compress the air in stages, and to cool it between stages by means of efficient inter-coolers. Thus the increase in pressure from atmospheric to desired delivery pressure is divided among two or more cylinders, and the temperature rise per cylinder is limited. The air is first compressed to a moderate pressure in one cylinder and thereupon passed to an intercooler wherein its temperature is considerably lowered and the volume of the air correspondingly reduced. The cooled air is then forced to the next cylinder and so on, until the final delivery pressure is attained in the last cylinder, whereupon the air is passed to an after-cooler and thence to the receiver or storage tank. The intercoolers between the cylinders and the aftercooler after the high pressure cylinder remove most of the heat of compression.

The most important advantage of compressing the air in stages and intercooling the air between cylinders is that power is saved—particularly in instances where the compressed air is passed to a receiver in which it remains for some time before being put to use, or where the air is transmitted a considerable distance from the compressor.

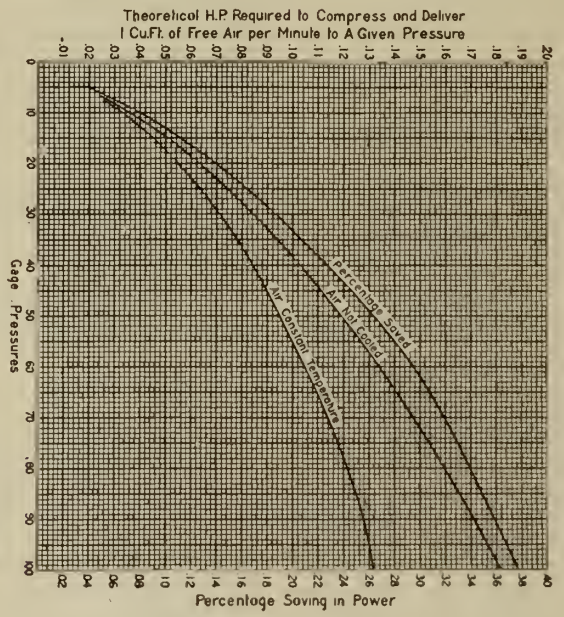

Theoretical H.P. Required to Compress and Deliver
1 Cu.Ft. of Free Air per Minute to A Given Pressure
Gage Pressures
Percentage Saved
Air Not Cooled
Air Cooled to Constant Temperature
Percentage Saving in Power

Fig. 1.—Theoretical power to compress air.

Power Saved By Cooling

Fig. 1 shows the theoretical H. P. required to compress and deliver 1 cu. ft. of free air per min. to a given pressure; first, when the temperature is maintained constant during compression, second, when the air is compressed without cooling. The first process is known as an isothermal compression and is approximated by compressing in stages and intercooling; the second is an adiabatic compression, and the difference in the power requirements for the two processes is the theoretical saving in power that under ideal conditions may be approximated by means of multi-stage compression and intercooling. No allowance is made in Fig. 1 for friction or other losses.

Kent mentions that in cards taken from the 2,000 H.P. two stage air compressor at the Quai De La Gare Plant of the Paris compressed air central station company, the saving realized by means of multi-stage compression and intercooling is 85 per cent. of the theoretical amount. Of this 77 per cent. is mainly due to intercooling the air between the two compression stages.

Another advantage of intercooling compressed air is that most of the water vapor in the air is precipitated in the coolers and for this reason trouble by freezing is avoided. This is of value, especially when the air is subsequently to be used in air agitators in ice plants, stone drills, riveting machines, paint guns, etc. As the air expands in doing work in the pneumatic machine, it must absorb heat; and since the process takes place rapidly or adiabatically, most of the heat is supplied by the air itself. If the air contains any moisture, this vapor will be condensed during the air expansion and the condensation will either damage the pneumatic machine, or cause other trouble as in varnish sprays where the water would be sprayed over the furniture surfaces causing bubbles and pitting. Further if moisture condenses and collects in air pipe lines, it causes water hammer, leaky joints, and loss of power by accumulating at low points and reducing the air passage.

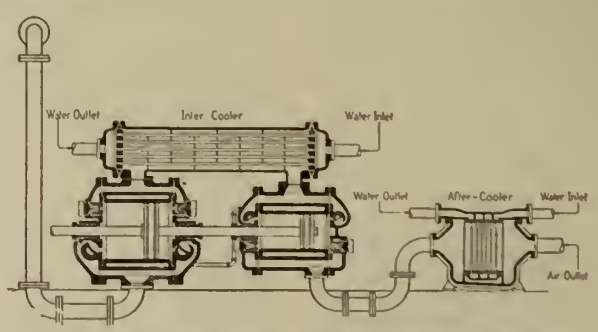


Fig. 2—Typical two stage air compressor with Inter and After Coolers.

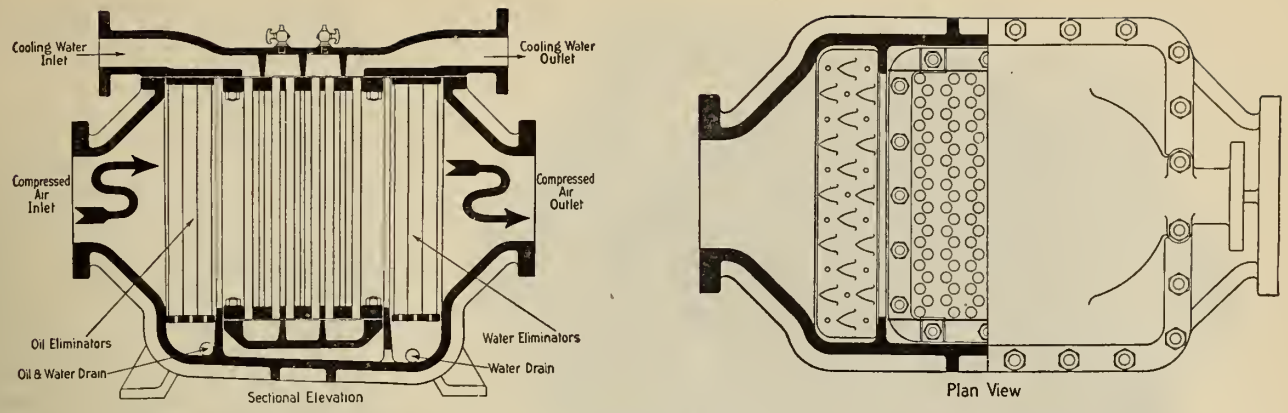


Fig. 3.—Sectional elevation of a typical intercooler, showing moisture and oil eliminators.

With single stage compression without intercooling, there is always danger of an explosion due to operating conditions. The air remaining in the clearance of the cylinder is at a high temperature, and is repeatedly recompressed, raising the temperature still further until a point is reached where the lubricating oil decomposes under the heat and vaporizes. The compressed air and vaporized oil form a mixture that may explode and cause serious damage.

Typical Two Stage Compressor

A typical two stage air compressor equipped with inter and after coolers is shown in Fig. 2. Air enters the low pressure cylinder through the open inlet valve, which, at the end of the suction stroke, closes. As the motion of the piston compresses the air filling the cylinder, the discharge valve opens automatically and allows the compressed air to pass to the intercooler where it is cooled and then discharged to the second cylinder or the subsequent stage. During its passage through the intercooler the air surrenders to the water practically all the heat of compression although some of this heat has already been absorbed by the water in the compressor water jacket. After the air leaves the last stage, it is usually conducted to an after-cooler, where the heat generated in the final stage of compression is removed in exactly the same manner as in the intercooler. The cooled high pressure air is then passed to the receiver where it is stored until drawn off for use as required.

A sectional elevation of a typical intercooler is shown in Fig. 3 and an outside view in Fig. 4. The air is carried around the outside of the tubes, and the cooling water through the tubes. As it is a simple matter to clean the inside of the tubes, very dirty water can be used. The current of air drawn across the tubes is continually divided or sliced into thin sheets or films, due to the close tube arrangement. Sluggish air flow or eddy currents are avoided. The air is brought into intimate contact with the tubes and a rapid and efficient absorption of the heat is effected. The use of straight tubes and the ease with which the cover plates can be removed contribute to rapidity and readiness in cleaning the cooler of scale deposited from the water. Any tube can be plugged or replaced without disturbing the others. Notwithstanding the small dimensions of the apparatus, the resistance to flow is low, and large quantities of air can therefore be handled with small frictional losses. Both oil and water eliminators are provided—thus practically all of the entrained moisture and oil is removed from the air. The importance of this has already been considered.

Fig. 5 is of interest inasmuch as it gives the heat transferred in B.t.u. per hr. per sq. ft. of cooling surface for 1°F. mean temperature difference between the air and water corresponding to different air and water velocities. The density of the air passing through the cooler generally varies from 0.6 to 0.025 lbs. per cu. ft. Thus, for an air speed of 50ft. per sec., the heat transfer rate from curve is about 48. This value however, must be corrected for the velocity of the water. Assuming the latter to be 1 ft. per sec., the correction factor from the curve is 1.4. Therefore 48 divided by 1.4—about 34, or the corrected heat transfer rate for a water velocity of 1 ft. per sec., an air velocity of 50 ft. per sec., when the density of the air is 0.2 lbs per cu. ft.

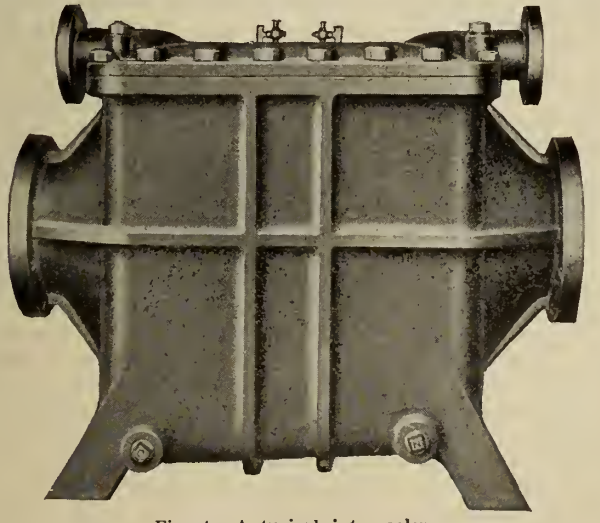


Fig. 4.—A typical intercooler.

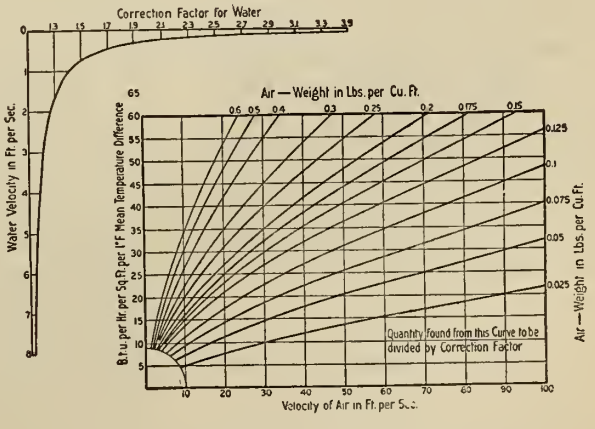

Correction Factor for Water
Air — Weight in Lbs. per Cu. Ft.
Water Velocity in Ft. per Sec.
B.t.u. per Hr. per Sq. Ft. per 1°F. Mean Temperature Difference
Air — Weight in Lbs. per Cu. Ft.
Quantity Found from this Curve to be divided by Correction Factor
Velocity of Air in Ft. per Sec.

Fig. 5.—Heat transmission curve for an intercooler.

Frequently the atmospheric air around power plants contains large quantities of dust and dirt and must be filtered before it is drawn into the air compressor. A typical dry air filter is shown in Fig. 6, and consists of a box open on two opposite sides for the admission and discharge of the air. Inside the filter are a number of vertical frames, the openings of which are so dimensioned that any given velocity of air flow can be obtained. The frame is built in a rectangular shape to which are fastened many fine parallel cotton threads forming the openings of the filter. The open sides of the filter box are protected by wire screens.

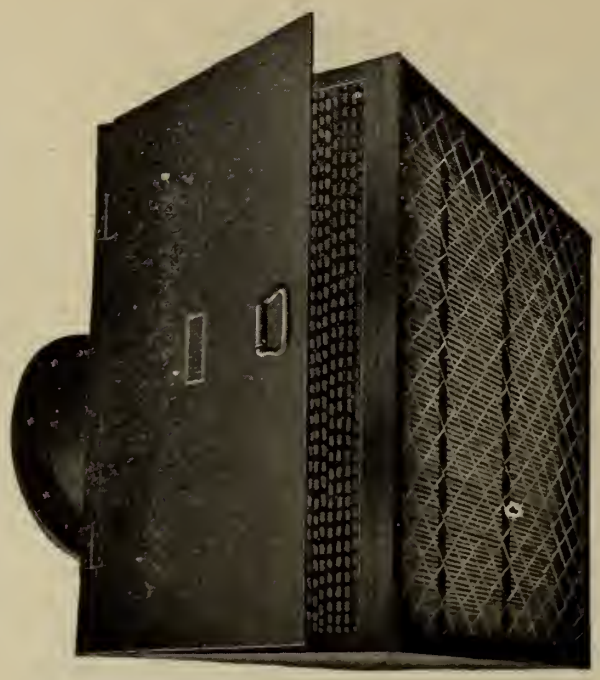


Fig. 6.—A typical dry air filter

Unless coal dust and dirt are removed from the air, they will enter the compressor cylinder, adhere to the oil film, and the combined dirt and oil will under the influence of the high temperature be baked into a gritty mass and deposited on the valves, etc. Under these conditions the machine must be shut down frequently and the valves cleaned, otherwise there is danger of an explosion.

As many filter boxes as required are usually coupled together. The system occupies relatively small space and is generally arranged in a basement underneath the compressor or outside of the power house as conditions may warrant. The filter frames can be cleaned without interfering with the operation of the system, simply by opening the door and removing one frame at a time.

INVESTIGATING COKING COALS

The obtaining of a good grade of coke from coals which seemed devoid of any coking property has been accomplished by investigators at the University of Illinois, Urbana, Ill., working in co-operation with the United States Bureau of Mines, by the employment of a specially devised low temperature coking process. As a result of the process, valuable by-products, in the way of ammonia, gas and tar, are derived.

The experiments were undertaken in connection with an investigation by the Bureau of Mines of the smoke problem at Salt Lake City, Utah. It was found that coke was regularly obtained from only a few coals tributary to the Salt Lake City district, and, if the use of coke, a smokeless fuel, was to be increased in that city, it would be necessary to demonstrate the possibilities of coking coals not regularly used for that purpose. Six coals from various Utah districts were tested.

Although, so far as present standards of coking indications are concerned, the coals tested seemed quite non-coking, treatment by the methods devised by Prof. S. W. Parr of the University of Illinois resulted in a yield of good coke amounting approximately 60 per cent of the coal employed. The coke is dense and of good texture, and seems adapted to use as a domestic fuel and for metallurgical purposes. In some respects the coke seems superior to anthracite for use in domestic furnaces. Slightly more than 20 pounds of ammonium sulphate, valuable as a fertilizer, were recovered per ton of coal coked. The gas recovered as a by-product is especially suitable for utilization in city mains. The tar oils obtained should lend themselves readily to cracking processes, thereby furnishing a product suitable for motor-fuel purposes, and may also prove a source of creosote oil and other wood preserving materials. These tar oils, on account of their marked drying properties, may also be available for paint and varnish manufacture. Other uses suggest themselves, such as direct combustion in engines of the Diesel type, as fuel for steam generation, as a source of heat for metallurgical purposes, the carburetting of water gas, and as the source of pitch as a binder for the briquetting of breeze, lignite fuels, etc.

The results of the investigation are of two-fold importance, indicating the possibility of coking many coals not generally considered to have coking qualities, and also constituting a factor in the solution of the smoke problem in communities not favorably situated for the obtaining of smokeless fuel.

DON'T FORCE A BELT

Many millwrights make the mistake of thinking that it is perfectly proper to force a belt to stay on its pulley by any means whatever. They seem to think that as long as the belt "runs" it is all right, and is doing as much as should be expected of it.

For instance, one millwright "took a piece of old three-inch rubber belt, pulled off one ply, wrapped it twice around the centre of a wooden pulley and nailed it solidly to the pulley," and then he goes on and says, "The belt immediately took its place on the centre of the pulley and stayed there."

It is true that nailing a ridge of any kind of belting on a wooden pulley to increase the crown will cause the belt to move over and run on the intensified crown, even though the alignment of the pulleys may be poor.

However, such a condition is hard on the belt, and if the millwright would give that side of the question some thought he would see that if the belt has much work to do it cannot endure.

Let us say that the width of the belt is 6 inches, and that the width of the ridge nailed on the pulley is only 3 inches. Six inches minus 3 inches equals 3 inches, which means that about 3 inches of the belt (1½ inches on each side of the centre) is not in contact with the driving pulley or driven pulley at all or is in poor contact. A very intense pressure between the belt and the pulley occur over the 3 inches of width of the ridge. In other words, 3 inches of width of the belt is compelled to do what 6 inches was intended to do.

Furthermore, with the rough face of the ridge rubbing against the equally rough face of the belt, and with the pull per square inch and the pressure per square inch doubled, it is evident that the wear on the 3-inch ridge is going to be greater than it would be on a smooth iron or smooth wooden pulley. It is quite possible that the slip is greater with the 3-inch strip than without the strip. At least the creep is as great one way as the other. From every angle, therefore, it is obvious that nailing a ridge around pulleys to increase crown is poor engineering.

It is far better to carefully align the pulleys and shafting so that the belt will run exactly as was intended by the designers of the pulleys. By using the low crown, the entire belt surface comes in contact with the pulley, both the load and the wear are evenly distributed.

In fact, pulley coverings should not be used at all. It has been proved time and again that the natural smooth face of a metal, wooden or other pulley is far superior to any roughened face. Rough faces are too hard on the belt.

A TWIN JET CONDENSER FOR A 20,000 KW. TURBINE

Herewith is illustrated the latest large jet condenser unit manufactured by t Wheeler Condenser & Engineering Co., Carteret, N. J., which is of special interest on account of its size and the operation of auxiliaries. It was built to serve a 20,000 KW. General Electric turbine at the Hauto, Pa., plant of the Pennsylvania Power and Light Co. Designed for 28 in. vacuum with 75 deg. injection water, it will handle a total of 25 000 g. p. m., or 12,500 g. p. m. for each removal pump.

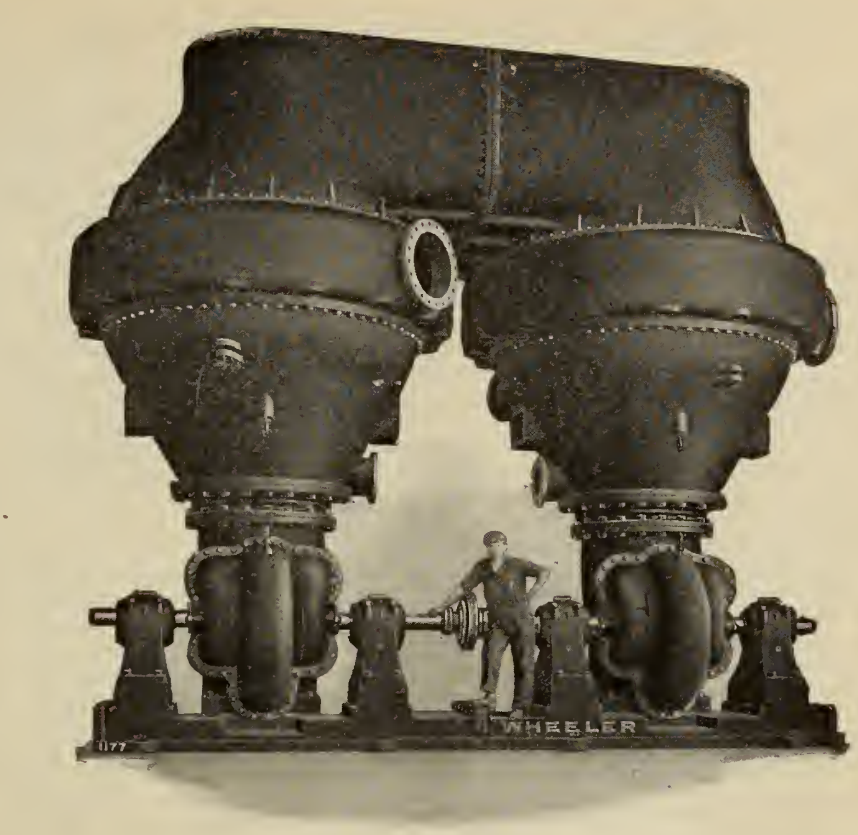
Twin jet condensers are frequently furnished for serving large units because they have greater flexibility, are easier to handle, and reduce the headroom. Each condenser body, as shown, is mounted over a separate removal pump, and will also provide with separate air pumps, so in times of light load or with cold injection water, only one-half of the unit need be operated, resulting in a saving of 50 per cent of the normal power. When in full operation, the water levels in the two bodies are equalized by means of a connecting pipe, flanges for which are the two lower ones shown on the condenser bodies opposite each other.

Both a geared turbine and motor are furnished to drive the removal pumps of this unit—each being large enough to drive both pumps alone—so that the load can be divided as required to maintain the heat balance of the plant by producing more or less exhaust steam, as can be utilized economically for heating feed water. These are not shown in the photograph, as they were sent direct to the plant, and could not be assembled in the shop where the photograph was taken. A feature of the pump drive is a magnetic clutch, which unites the shafts between the inside shaft bearings. It permits either pump to be driven independently of the other, without interfering with continuous operation, when only half of the condenser is to be operated.

As will be noted from the photograph, an expansion joint is provided between each condenser body and its removal pump. By this arrangement, the condenser body is suspended from the turbine nozzle, while the removal pump and driver are mounted upon a rigid foundation; the expansion joint in this way eliminates the large expansion joints usually placed between the turbine and the condenser.

Another point of interest is the vertically split casting of the horizontal double suction tail water pump serving each condenser. When it is necessary to inspect or repair the rotor or any of the wearing parts, it is simply a matter of removing the bolts, and uncoupling the rotor. Before this design was developed, considerable time and effort were required to get at and remove the rotor.

This huge condensing unit will be served by two large Wheeler steam jet air pumps of the combined surface intercondenser and heater type, and two turbo air pumps, each pump being large enough for one condenser. Boiler feed make-up is circulated to the intercondenser and heater of each steam jet air pump.



Large jet condenser for a 20,000 k.w. turbine.

MINING FATALITY RATE

According to reports received by the United States Bureau of Mines from the various state mine inspectors, 152 men were killed during September in and about the coal mines of the country, as compared with 197 killed in the corresponding month in 1920. The 1921 figures show a decrease of 45 fatalities, or about 23 per cent., from the record of the same month of last year. Based upon an estimated output of 42,229,000 short tons in September, 1921, the fatality rate is 3.60 per million tons produced. The corresponding rate for September last year was 3.66 and the production of coal was 53,810,000. The production of coal during September, 1921, represents a decrease of 22 per cent.

The average number of lives lost during September of each year from 1913 to 1920 has been 189. The production of coal has averaged 51,886,000 tons showing a fatality rate of 3.64 per million tons as representative of the month of September for the past eight years.

During the first nine months of the present year 1,455 have been killed by accidents at coal mines, against 1,686 killed during the corresponding months of 1920, a decrease of 231 fatalities, or 14 per cent. The output of coal for the same months was 362,800,000 short tons in 1921 and 473,100,000 tons in 1920, a decrease during the present year of 110,300,000 tons or 23 per cent. These figures represent a fatality rate of 4.01 per million tons mined in 1921 and 3.56 per million tons mined in 1920.

Of the total of 152 fatalities during September, 30 occurred at the bituminous coal mines in Pennsylvania, a decrease of 15 from September a year ago; 25 in West Virginia, a decrease of 6; 14 in Illinois, a reduction of 3; 6 in Kentucky, a reduction of 8; 5 in Ohio, a reduction of 13; 5 in Alabama, a reduction of 4; 3 in Indiana, a reduction of 12. At the anthracite mines in Pennsylvania, 41 men were killed, as against 20 during September of last year.

The Quigley Furnace Specialties Co., Inc., New York have disposed of their Pulverised Fuel Department to the Hardinge Company of the same city. The engineering department of the Quigley Company in connection with the pulverized fuel division has been taken over in its entirety, so that the Hardinge Company will be able to carry on the business without a break. This new arrangement leaves the Quigley Co. free to devote their efforts to the refractory specialty business, which has assumed proportions that call for their full attention.

It is understood that the electric power plant at Morinville, Alberta, owned by Mr. E. A. Brault, will shortly be changed from a gasoline engine to a steam engine prime mover.

Central Oiling Systems for Power Plants

The Treatment of Oil For Continuous Use—Correct Lubrication —Impurities—Precipitation — Filtration — Entrained Water — Action of Heat—Filtering Materials—Separation of Water—Oils Themselves Nearly Perfect

EVERY known device that will assist in producing the highest mechanical efficiency in power manufacturing apparatus is used in the modern power plant. Very prominent among changes in recent years is the item of scientific lubrication.

What is meant by scentific lubrication? It means: Choosing the correct lubricant for a particular class of service; distributing the oil to the bearings through an automatic oiling system that is positive and needs no personal attention; applying the oil in such a manner that the least possible energy will be consumed in internal bearing friction; practising the utmost elimination of waste by recovering every drop of the used oil after it has passed through the bearings, reclaiming it, and putting it back into the system.

Correct Lubrication

Stream feeding of the proper quality of oil to the engine bearings is recognized as being the ultimate in perfect lubrication, and is the limit beyond which friction cannot be reduced by lubrication. Correct lubrication requires that the thinnest possible film of the most friction-reducing fluid must possess sufficient cohesive property, that its film be unbroken and never permit the rubbing surfaces to come in contact, even in spots. It must not have a body any heavier than is just enough to maintain this film, for unnecessary energy will be lost in overcoming the internal friction of the fluid.

In order that the oil possessing the least amount of internal friction or viscosity can be used on a bearing and yet maintain the continuous lubrication film, it is necessary to put as much oil on bearing as it will take and introduce it in the journal at the point of least film pressure. This flood of oil insures an unbroken film of the most friction reducing fluid; carries away worn metal, which, if allowed to remain will cause unnecessary wear; keeps the bearing cool by absorbing what frictional heat there may be generated and gives to that bearing every condition that makes perfect lubrication possible.

The merits of stream feeding of oil for bearing lubrication are unquestionable. Although when one thinks of the enormous expense necessary to keep a stream of new oil running on all bearings in a plant, the cost of this kind of lubrication seems to be almost prohibitive; but the impossible expense of flood lubrication vanishes when a system may be installed for collecting this used oil and continuously circulating it from a large reservoir to the bearings and back to the reservoir again. There is no wear-out to good oil, if it is properly separated from the impurity which it has picked up during use. Good oil may be used indefinitely with positively no chemical change and only a very small decrease in volume due to slight evaporation. When an efficient filter is added to this oil circulation system, a combination is had that will deliver perfect lubrication to all bearings at a cost that is almost nothing.

Impurities

Used lubricating oil contains various kinds of impurities which it picks up during its travel through the engine bearings, drip pans, oil conductors, etc. These impurities must be entirely removed before the oil is fit for re-use. The character of this foreign matter differs with the kind of oil used, the class of service the oil is used in, bearing temperature, atmospheric conditions surrounding a plant, quality of water and kind of boiler compounds used. The objectionable impurity is composed of grit, graphite, grease, slimes, worn metal, paraffine, sludge and water, but for its clarification in a gravity filter it may be roughly classified as, first, those impurities heavier than oil, and second those impurities the same weight as, or lighter than oil.

Lubricating oil has been passed through sand, charcoal, sawdust, cotton waste, Fuller's earth, and even water as a means of separating from it all of those impurities which impair it as a lubricant, and make it unfit for reuse. The quality of the recovered oil generally has been pretty good after the use of these various filtering media. However, the requirements of a modern oil circulation system, in average size power plants, demand the continuous purifying of too much oil per hour for the use of a drip filter bed, of any porous material. Such a bed to be efficient and have enough capacity would have to be too large to be practical.

Oil filters of the latest design used in handling continuous flowing large capacities, resort to other methods than the use of a filter bed, composed of coarse materials. The efficiency of these new filters has been very high, for they have used the value of precipitation to its fullest extent. This precipitation action is combined with the use of a filtering medium of such material that it can present a large area of surface compactly in a small amount of space. Those impurities heavier than the oil are removed by the process of precipitation, and all impurities possessing the same weight as or lighter than oil, in which they are suspended, are removed by filtration. It is found by handling each of these two groups separately and by taking advantage of a very thorough process of precipitation, that in the filtering action, a finer medium may be used and a better quality of purified oil will be the result.

Precipitation

Precipitation can be the result of the action of some chemical reagent or the natural settling by gravity of any impurity heavier than oil. If the oil be permitted to stand at rest in a vessel during a long period of time, and be free from the slightest movement, all impurities held in suspension will seek a stratum in the oil depending entirely upon their relative weights. Impurities heavier than oil will rest on the bottom of the vessel, while lighter impurities will seek the surface and remain on the top of the oil. The best known example of this precipitation or separation by gravity is found in the paint bucket. The heavy coloring pigments will settle to the bottom of the bucket after separating from the vehicle, while the lighter thinning liquids rise to the top of the bucket. The thoroughness of this separation depends upon the length of time the paint is allowed to stand at rest.

Filtration

Filtration is another name for screening the oil through a fine mesh or porous substance capable of permitting the clean oil to pass through the small openings. Filtration of a liquid may be compared to the screening of a dry substance. Uniform, dry, granular substances are separated from the large undesirable sizes by passing the grains through a screen. A liquid is made free of the large undesirable matter by passing the liquid through a filter. The two processes are identical for the action of the screen and the filter are the same.

Filtration is a continuous method of removing impurities, in which method time is not as much of a factor in determining its most perfect performance as is the density of the filtering material. If the liquid be allowed to pass through some material having microscopically small openings, exactly uniform in size and shape, perfect filtration of the liquid would be the result. The highest commercial degree of perfection is reached when the clarified oil has been freed from all injurious impurities and its condition returned to such a state, that, for the duty it is to perform, the oil is as good as new. To make it any better would require an expenditure out of proportion to the gain of value in the oil.

A drop of lubricating oil is composed of thousands of minute globules or mo-

lecules of oil. In a pure oil that is highly refined, there is only a very small percentage of foreign matter between these molecules, and the molecules, are very close together. A poorly refined, or impure oil, contains a great deal of foreign matter between the molecules, so that a drop of this substance possesses only a few scattered molecules of real oil, and consequently is a poor lubricant.

Entrained Water

All used engine and turbine oils, due to contact with steam, collect more or less water, which must be extracted during filtering process. Free water, or water that is in no way mixed with the oil, will settle rapidly by gravity; that is, the water is so much heavier than the oil that it falls to the bottom of the containing vessel, while the oil rises to the surface of the water. The separation is complete and almost instantaneous. Where live steam comes in contact with the oil, however, it is possible for the steam to become so entrapped in the body of the oil that it will not condense as water, but will remain suspended in the oil as vapor until a point of saturation is reached, above which the steam will collect and separate as free water. This entrained water that has been trapped between the minute globules of oil will not settle out by gravity under ordinary conditions—no matter how long the oil may remain in a state of rest. It must be remembered that every molecule of foreign matter contained in the oil, including entrained water, is so covered with a coat of oil that the oil prevents the particle from separating.

Action of Heat

When oil is heated to a temperature of approximately 180 deg. F., the cohesive force between the oil globules is temporarily weakened, sufficiently to spread the globules apart and to release the foreign impurities which are entrapped between them. This cohesive force or viscosity, possessed by the oil, is a necessary lubricating property. Nevertheless, this physical property must be temporarily changed during the process of purification. Increasing the temperature of the oil reduces this viscosity, and at a temperature near 180 deg. F. depending upon the quality of the oil, the oil loses its cohesive force and becomes "thin" as water. While at this temperature, if it be allowed to remain approximately in a state of rest for a comparatively short time, all the water and other impurities heavier than the oil will precipitate. It is upon this principle that the separator in the latest purifiers is based. So efficient is its action that only a very small per cent of the impurity is left to be removed by the filtering medium.

Filtering Materials

Of all the various kinds of filtering material used in a continuous flow oil filter for removing those impurities that will not settle by gravity, nothing has been found that can equal, in every respect, a closely woven heavy grade of cotton cloth. It is a material that is cheap and will not dissolve or possess fine particles that will work into the oil and find their way to the bearings to clog and injure them. The material provides uniform microscopically small voids or openings for the passage of oil so that the straining action will be uniformly complete. This material is such that an extended area of straining surface can be provided for the oil. It is the area of surface and not the depth of medium that does the straining. In passing a dry material through a number of screens of the same mesh, it is the first screen that does all of the separation. Any size that will pass through the first screen will pass through each of the succeeding screens having the same size openings, no matter how numerous these screens may be. This cotton cloth is of such nature that it adapts itself to the best approved mechanical arrangements, and when firm and strong will withstand many thorough cleanings before being thrown away.

The use of a low pressure head of 4 to 6 in. to force the flow of clean oil through the cloth is very desirable. For the best results, this pressure should be uniform over every square inch of the area of cloth and remain constant during its entire period of use.

When it is necessary gradually to build up a high pressure head upon the filtering medium as the sediment accumulates, a stream of dirt as well as oil will be forced through the cloth which would otherwise be completely obstructed. The only duty of a filtering medium is to separate impurities from the oil; but, if, for additional capacity, under either normal or overloaded conditions, this action has to be sacrificed to any degree, the purpose of the filter is lost.

Separation of Water

The worst impurity to separate from oil is entrained water, which is held in suspension as an emulsion. Free water separates readily, but entrained water will only settle out when the surrounding conditions are ideal. Heat at a temperature around 180 deg. F., state of absolute rest in the body of the oil, and the action of gravity during a long period of time, are all necessary conditions which will aid in separating an emulsion, provided its resistance is not too high. While these conditions can be approximated in a continuous flow filter, it is only in a filter that will handle oil in batches, that their value may be used to their fullest extent. Better clarification of oil can always be had in a batch filter, than one built for continuous flow. The element of time which enters in their action is a most important factor.

An oil filter is a device that will remove physical impurities from dirty oil, and will retain those impurities until they are removed by some outside means, therefore, a filter that successfully performs these functions requires periodic cleaning. Whether a filter be classified as good or bad depends almost as much upon its easy accessibility for inspection and thorough cleaning as on its capability for purification. In the selection of a type of filter for any class of service, it is important that its arrangement for accessibility be given much attention.

In view of the ever rising cost of lubricating oil and its enormous consumption in the operation of the present day industry, an efficient lubrication and filtration sytem, with its wonderful economical possibilities, is being welcomed as most necessary engine room equipment. Correct lubrication for the increase of plant efficiency is being acknowledged as a science.

The importance that scientific lubrication is playing in our industrial management is evidenced by the disposition on the part of large concerns toward the employment of expert lubrication service. Their duty is to search out power losses, correct wastes in the use of oils, to save time and labor by the prevention of bearing troubles, and to insure at all times more power at less cost. The central oiling and filtration system, delivering flood lubrication of a correct oil mechanically, gives just this kind of service and performs its duties automatically.

There is very little doubt that the question of lubrication in power plants is receiving more careful attention than it has in the past. There are many reasons for this, among which are the increasing demand for, and the greater cost of, oil. Lubricating oils as marketed today are the result of years of experiment, and little improvement can be hoped for in the oils themselves. The field which promises maximum results regarding efficient lubrication lies in better and more scientific methods of application, the selection of the proper grade of oil for the purpose and the reclamation of used oils so far as this is possible. While the cost of lubrication may appear small in proportion to the total production cost of power, poor lubrication and inattention to the proper use of oil will assume an importance out of all proportion to the cost of a suitable oil and attention paid to its application.

The logical solution of these conditions is the use of a central oiling and filtration system.—Power Plant Engineering.

The American Engineering Company Philadelphia, have issued a new bulletin entitled, "The Central Station and The "Taylor Stoker" which describes and illustrates very fully a number of installations in public utility plant. A double page illustration of four great cities Taylor stoked is very effective, while there is a detailed description of the apparatus at the back of the catalogue.

The Drake Non-Clinkering Furnace Block Co., Inc., New York, have issued a catalogue describing their product, and its application to various styles of stokers and furnaces. The stoker applications include practically all the well known types in general use, and the results of a comparative test carried out on two B and W boilers with and without the blocks is included. A list of users of the blocks is given on the back page.

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An Unexpected Result

AN ACCIDENT which resulted in the death of ten persons and a large amount of property damage was recently caused by the carelessness of a workman in taking a cover off a gasoline tank. This car contained a particular highly volatile type of gasoline, known as casing head gasoline. The gasoline is also known, according to the "Traveller's Standard" which describes the accident, as "wild" or "natural gas" gasoline.

Thec causes which led up to the disastrous effect seem to have been the omission of certain precautions, and the commission of grave errors. There is a safety valve on each gasoline tank car, which is supposed to lift at a pressure of 25 lb. per square inch, but which is also, according to regulations, supposed to be slacked off before the cover is taken off the dome of the tank, thus releasing all pressure that there may be inside. The workman who was detailed to unload the car first neglected to release this valve, and therefore the pressure, and secondly, on attempting to turn back the cover of the dome with a bar, and not succeeding, took a hammer and chisel to start the cover back. This practice is specifically forbidden by the regulations. When the dome cap was started, the gasoline being under pressure, forced some of the vapour through the cap, and a spark presumably from the chisel, ignited this vapour, with the disastrous result already mentioned.

It seems that no amount of warnings, regulations, or propaganda can ever imbue men with a sense of responsibility, or keep it alive in them day in and day out. It is probable that this man who was doing this was fully aware that he was breaking a regulation, and it is quite probable that he had done so before, and thought he could save a little time or a little trouble by disregarding it on this occasion. He not only lost his own life but caused the death of others, and huge damage besides. In most cases regulations are made for the purpose of protecting life and property, and are made after due consideration of their effects as regards retarding work. This loss of time is considered of less importance than the danger that would ensue if the regulation was not there. It seems to be inevitable however, that familiarity shall breed contempt in the minds of those who should be governed by these regulations, and sooner or later their contempt is visited by some calamity. This carelessness is not confined to any one industry, but can be found almost wherever men are engaged in occupations that carry a hazard of any kind. Even power plant men are not immune to this form of carelessness, and it is not unusual to find guards around eccentrics or crank webs removed for some repair, and never replaced. It is not unknown either for electric station operators to be killed by working in narrow places on live wires which could have been switched off with a little expenditure of time or trouble. The remarkable part of the whole thing is that men who would ordinarily kick loud and long if ordered to do any dangerous thing, will of their own free will break regulations made to safeguard them, for the sake of saving themselves a moment's inconvenience. The safety movement may not be always conducted in the most wise or effective manner, but it has performed and is performing a great service. It seems, however, that nothing short of a change in human nature will ever have the best results, and as some short-sighted reformers have found out, human nature cannot be changed by regulations or laws, however well meant.

Uniform Boiler Laws

WE UNDERSTAND that there is once more an effort being made by some of the various provincial authorities, to obtain a uniform law covering the construction of boilers throughout Canada, and including of course the various fittings and mountings comprised in the complete boiler. We have commented at various times on the desirability of such laws, not only for Canada, but also for international purposes. Why there should be any difference in boiler construction regulations is hard to see, because there can be only one correct standard, and that is the highest. There is but little difference in the laws of the various provinces of Canada, but in the States conditions are much more chaotic. The American Society of Mechanical Engineers has formulated a code, which we believe is high enough in its requirements to satisfy the conditions in any State, but we are not aware that that code is compulsory in every State.

There are some authorities with such wide experience and knowledge of conditions that their rules commend themselves to all people as being all that is desired. The oldest authority and the one with the highest standards and widest experience is probably the British Board of Trade, and this authority has recently enacted an improved code for boiler construction, after deliberations by the leading engineers of several of the great classification societies, in collaboration with the Board's own engineers. The various rules of the Canadian provinces are largely based on the Board of Trade rules as they existed at the time of the formulation of the provincial rules, and we cannot imagine that the provincial authorities could do any better than to adopt the Board of Trade rules in their entirety. This would make a uniform rule not only in Canada, but in most of the British Empire. These rules have immensely better backing behind them than any rules made by a provincial authority, as these authorities

are as a rule, merely local. In a matter of this kind, it seems to us that local pride might well take a back seat, and the general good of the engineering industry be considered. We cannot help feeling that any body of engineering talent which might be gathered together in Canada to consider this question, could not formulate a code which would be in any way superior to that promulgated by the Board of Trade, and the adoption of a recognised authority's requirements would smooth out any feelings of local jealousy that might crop up between the various local representatives.

Why Not a Dominion Wide Certificate?

IN conjunction with the effort to establish uniform laws for boiler construction, would it not be a good idea to obtain uniform laws for engineers' certificates? Is there any real good reason why one province of Canada should refuse to recognize the qualification granted by another one? Well, we would admit that at present there is, but that condition is fast being adjusted. The requirements of each province are gradually coming nearer and nearer to each other, and the policy of the closed door between provinces is losing whatever excuse it had.

Now the same objections are operative when discussing uniform regulations for engineers as are in force when discussing uniform regulations for boilers. They are, chiefly, the petty jealousies of local authorities, who will not admit that the other party may have as great a share of wisdom as themselves. Their own prestige is the thing that is paramount with them, and not the good of the great body of engineers or the good of the engineering industry. If this were not the case uniform construction laws would have been in force long ago, instead of still being in the talking stage. It is probable that before any real result is arrived at, the matter will have to be taken out of the hands of provincial authorities altogether, and handled by a Federal Government department, just as the marine regulations are handled by the Department of Marine. We are a very much governed people in Canada, and the multiplicity of Governments and authorities under those Governments leads oft to confusion. There are some things that are better for the sake of all concerned to be put under a central authority.

How does the engineer stand today, with the different Provincial regulations? He may obtain in the Province of Ontario, a certificate which entitles him to run a plant of unlimited size. Having obtained that certificate, he may decide that some other part of Canada offers him a fairer field, or we may say larger opportunities. He finds on moving out of Ontario, that he may be granted a temporary permit of the same, or more likely a lower grade, and after a certain period, he must present himself for examination in his new province. Now he is not only up against the proposition of passing an examination which may be made three times as stiff as the one he has already passed, but he is confronted with local influences and local prejudices which may effectively prevent him obtaining the certificate, no matter what his ability is. One may say, "Oh, the examining boards are above such petty feelings." Well, perhaps they are, but not all of them all of the time. Suppose a local man in a town, well known to the examiners and most of the engineers, and popular with both, is after a certain position. Opposed to him is a man from another province, whose ability to land the job depends only on his obtaining the local certificate. How much chance has he to obtain the certificate, and although he may eventually obtain it, is it probable that he will do so in time to beat the local man out?

This may be a very desirable thing from some points of view, and there are perhaps many men who would exclude engineers from other provinces altogether and make the stationary engineering profession a closed circle, keeping those in, who, are already here, and keeping all others very much out. That is not, we think, the general attitude. The average man likes to think that he can hold his own against all comers, without special legislation to help him out. Besides, a man never knows what urgent reasons there may be for him to move his home to another province, when his ability to earn a living at his chosen profession will depend on his ability to obtain a certificate.

There have been cases where men from outside of a certain province have been deliberately refused the opportunity to even sit for examination, because there were a large number of local engineers out of positions. There have been cases where the man from outside has been refused a certificate because the authorities felt there were too many outsiders coming into the province. They may have been all right from their point of view, but should it be in the power of any authority to interfere with a man's freedom to work where he chooses if he has the ability? As long as each province has its own governing authority it is inevitable that there will tend to be discrimination against men from outside the Province. Would it not be fairer for everybody, if, when a certificate was once granted, it should be good all over Canada? This would be easy enough to arrange, and easy to handle, and would result in a higher standard all round. There need be no increase in cost to anybody, and there should if anything, be a reduction in the fees to be paid by the candidate for a certificate. The fees charged in some of the provinces to day are out of all proportion to the value of the certificate when it is obtained, and the salary that can be earned by its possessor. The reason that the fee is so high is that a comparatively small number of engineers have to pay the salary and expenses of a comparatively large number of examiners and their staff. In some provinces these examining boards do nothing at all but hold examinations, while another body looks after boiler inspection work, and still another body after general factory inspection. There is no good reason why the surveyors or inspectors of engines and boilers should not be examiners, as they are in the Department of Marine in Canada, and the British Board of Trade. This would tend to economy, and furthermore, the expense could be borne proportionately more by the boiler owner, who is much the better able to bear it, than the none too highly paid engineer. The vexatious renewal rule, which is merely a method of collecting revenue, and serves no other purpose, could be abolished if the certificates were Dominion wide in their scope, and granted by a central authority. If a man is capable of running a plant of a certain capacity in the year 1920, he should not have to pay a fee for a certificate saying he is fit to run it in the following year. Unless he commits a serious breach of regulations, or is proved incompetent in some manner, he should hold his certificate for ever, if once obtained.

Supposing all the representative bodies from the different provinces met together and drew up a code of qualifications, covering third, second and first class engineers. As a matter of fact, two grades ought to be quite sufficient, because the third class certificate is practically only a fireman's qualification, and it is in the opinion of many people, somewhat of an injustice to make a fireman carry a certificate at all. However, whether two or three grades were decided on, this committee could frame standards of examination which would be acceptable to every province concerned. These regulations could then be submitted to the Federal Government, to em-

body in a Federal law, and endorsed by a Federal certificate. The provincial staffs could still carry out the examinations for the Dominion Government, in addition to their other duties, and examination fee could be divided pro rata between the Dominion Government and that of the province in which the examination was held. The staff at Federal headquarters could be of the smallest possible dimensions, that is allowing for the fact that it is a government department. Its duties would practically be only those of recording and registering the certificates issued. The examiners in the different centres would have no possible reason for discriminating between candidates, as a successful candidate might be as likely to travel away from his own district as to stay in it. The examination fee could be considerably reduced, as the examining board's staff could be used for the purposes of boiler inspection, which would furnish enough revenue to carry them. The renewal system could be dispensed with entirely. Incidentally, the examination could be made of a higher standard and that standard enforced, as it is not at present, in many cases. Every engineer throughout the Dominion would be on equal footing, and if he went out of the Dominion, a certificate granted from a Dominion authority would carry a much greater weight with foreign countries or other parts of the British Empire than a certificate granted by a local authority.

The objections to such a scheme, would no doubt, come from those provinces which have at present poor or no regulations for the examination of engineers. It is a scheme that should commend itself to engineers in general, and could be worked out without inflicting any hardship on anyone. After Dominion regulation came into force, all those holding certificate from a provincial authority that had formerly issued certificates, could exchange them for a corresponding certificate isued by the Dominion. Those in charge of plants in provinces where there were no regulations in force could be allowed to continue in charge of those plants for a period of twelve months, on a special permit, and come up for examination after that time. In the case of men who had supervised plants for five years or over, a certificate of service could be issued which would be good for the remainder of their working days. There would be other details to be worked out, but nothing of a very difficult nature. The Federal authority would have to maintain a small staff of inspectors who could drop in, preferably unnanounced, on the various local examiners, from time to time, and see how the examinations were being conducted. This would keep them on the mark. On the other hand, an engineer who thought he had a grievance, could take his case to the Federal authority, which would investigate it impartially. As it is at present, a man who thinks he has been unfairly treated has no appeal at all, unless he can, by devious means, gain the ear of the Minister who is above the examining board.

There may be other objections to such a method of qualifying engineers, but the suggestion is put forward here for what it is worth, and comment is invited from those interested.

A Study In Contrasts

THE FIRST public railway for steam locomotives was opened between Stockton and Darlington, England, by Edward Peese and George Stephenson on September 27th, 1825. This event caused great excitement, and nearly everyone prophesied that the "iron horse," as the engine was called, would be a failure. The train weighed about 90 tons, and consisted of six wagons loaded with coal and flour. Then came a covered coach which held the directors and proprietors, with twenty-one coal waggons fitted up for invited passengers, these numbering nearly 600. Stephenson's engine, which was named the "Locomotion," had a ten foot boiler and weighed not quite 1,500 pounds. As six miles an hour was supposed to be the limit of speed, it was arranged that a man on horseback should ride on the track ahead of the engine, carrying a flag.

The train was started without mishap and many of the spectators attempted to keep up with it on foot, some on horseback galloping across the fields to accompany this new means of transportation. After a few minutes Stephenson got impatient and shouted to the horseman with the flag to get off the track, for, to use his own words, "I am going to let her go." Spectators and passengers were alike afraid, but hung on tight while Stephenson opened up the throttle. Soon he was going at 12 miles an hour, later finishing with a glorious spurt at the rate of 15 miles. Spectators were left far behind, and one newspaper reporting the incident said that the performance had exceeded even the most sanguine expectations.

Compare this first locomotive with the modern type which is capable of eating up distance at the rate of 82 miles per hour. Hundreds of improvements have been made in addition to that in speed until at present we have a carefully prepared and massive piece of mechanism which excites wonder even in the heart of locomotive men themselves. The latest achievement in locomotive history is the "Thinking Engine."

The danger of collision has been ever existent, and unfortunately has been the means of a heavy loss of life. Some weeks ago, A. R. Angus, an Australian, demonstrated in London, England, a new device which he has invented, and which makes the locomotive so safe from collisions that he named the engine the "thinking locomotive." Three tests were made. In the first, two locomotives going head on towards each other at great speed on a single track were automatically stopped on approaching the danger distance without the intervention of the engineer. In the second test a locomotive heading towards another standing still on the same track was similarly stopped, and in the third test a rapidly moving locomotive overtaking one moving slowly was stopped.

On another page we give a brief description of the device. The thought, however, which remains uppermost in our minds is that marvellous inventions are continually being perfected and yet attract practically no attention. Here we have a life saving device which practically eliminates the human element, yet we sit back and take it all for granted. It is to be hoped the invention proves a success and a commercial possibility, so that all engines may be equipped with this added safety measure. The present safety condition of our railroads is excellent, but anything we can do to make them fool-proof, so far as switch operators are concerned, would be well worth while.

IT IS REPORTED by a British investigator, Mr. F. G. Cawston, who has been studying leprosy at Durban, that the administration of colloidal antimony appears to produce good effects. According to the British Medical Journal, he found that lepers in an advanced state of the disease, with all of their fingers and toes suppurating, were helped to such an extent by this treatment that the suppuration entirely ceased.

Progress in New Equipment

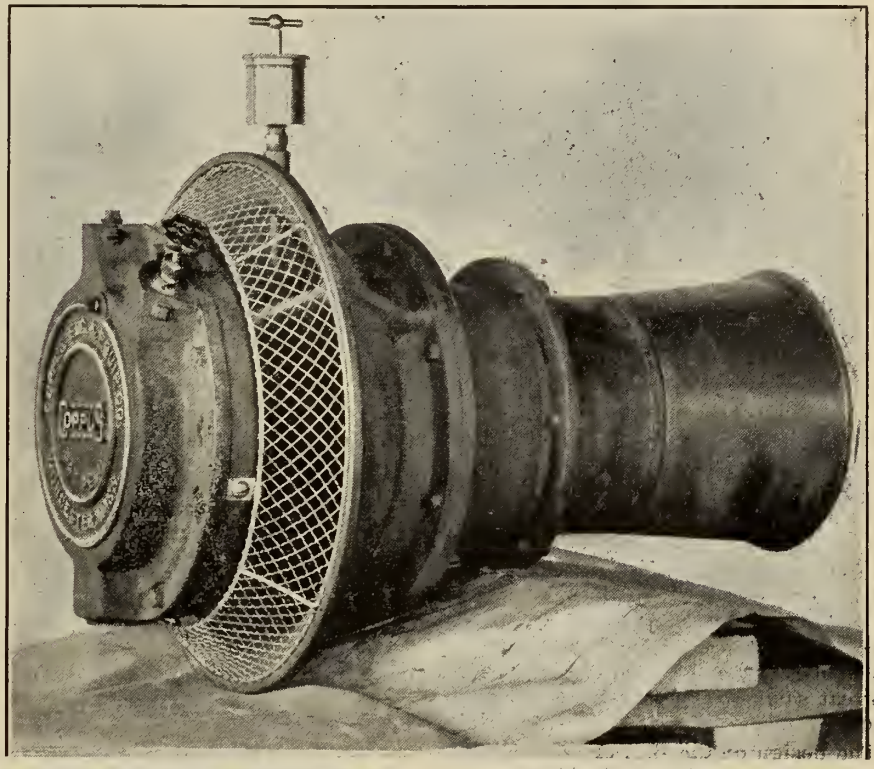
COPPUS VANO BLOWER

The field of usefulness for propeller blowers, until the advent of the Coppus VANO Blower, has been very limited. With the exception of low duty ventillating fans, propeller blowers have been used almost exclusively for undergrate draft on hand fired boilers or with chain grate and overfeed stokers, on account of their low efficiency at higher pressures.

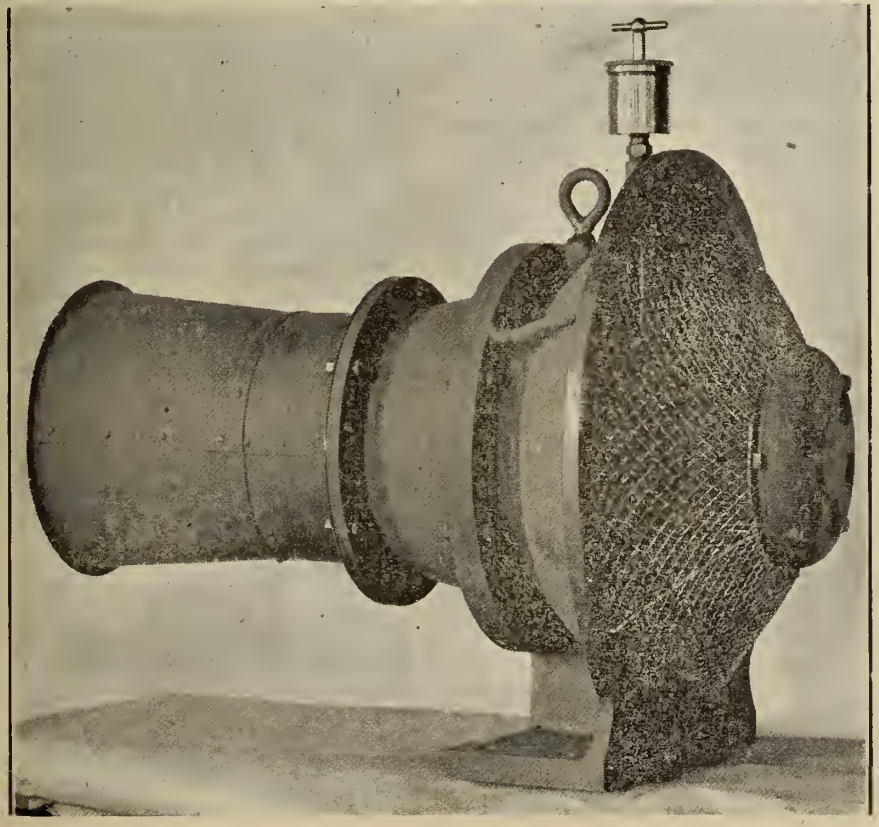
Coppus VANO Blowers are screw-blade propeller blowers which deliver the air parallel to the axis—in other words, the air leaves in the same direction as it enters. They differ, however, from all other propeller blowers in the following three points;—

1. They operate against pressures up to 8" water and, therefore, can be employed where, until now, only centrifugal blowers could be used.
2. Their efficiency runs up to 80%.
3. The power consumption AT CONSTANT SPEED is practically unaffected by variations in air delivery or pressure.

The principal feature of the Coppus VANO Blower is the stationary guide vane of peculiar design beyond the propeller. The air current leaving the propeller is radially sub-divided by the individual guide vane blades and taken up by them without shock. The guide vane blades which have a curvature, increasing in the direction of the rotation of the propeller, concentrate the air current and give it a further acceleration inside of the stationary guide vane so that a considerable part of the end thrust is thus taken up by the stationary guide vane casing. The air streams, into which the flow of air has been sub-divided by the guide vane blades, leave the guide vane casing, on account of the kinetic energy, slightly rotating and convergent toward the axis so that the smallest section of the air flow is reached beyond the guide vane casing.



Blower With Turbine Drive



Blower With Motor Drive

On account of the three principal features enumerated above, these blowers are adapted to many uses as:—

Undergrate or forced draft for hand fired boilers, chain grate, overfeed and underfeed stokers.

Induced draft.

Main—and individual room or tunnel ventilation for mines.

Air heating and drying installations.

Cooling of electric motors and generators.

View of guide vanes.

Ventilation of factories, boiler rooms, ships, tunnels, etc.

Coppus VANO Blowers have an efficiency as high as 80% for both high and low pressures. The power consumption is, it is claimed, much smaller than any other type of blower of the same capacity and pressure. On account of this in case of an electric drive, much smaller sized motors can be used, which means a great saving in first cost and in operation.

The design of the Blower is such that the air enters and leaves the blower parallel to the axis. They are high speed machines, which require a comparatively small driving unit. As a result of these features and the compactness of design, the blowers can readily be installed in pipe lines, which is a distinct advantage in ventilating, heating and drying systems. They work with the same effect and efficiency when installed at the entrance or at the end of the air duct operating as blowers or exhauster, respectively.

To deliver air through very long pipe lines, high initial pressure is necessary, as it is impossible in mine practice for instance, to keep air ducts tight, especially at the joints, the losses on account of leakage which, of course, increase with higher pressures, are often many times the actual air delivery at the discharge of the pipe. Instead of using a centrifugal blower delivering a certain capacity at, for instance, 12" pressure, three Coppus VANO Blowers delivering the same amount of air at 4" pressure can be installed on series equi-distant apart in the pipe lines or air duct. The losses through leakage are thus reduced to a fraction of the losses at high pressure.

Coppus VANO Blowers allow the reversing of the direction of rotation which changes the direction of the flow of air through the blower. In such a case, they deliver from one-third to one-half of their normal capacity.

The most remarkable feature claimed for the blower is the constant power consumption at constant speed practically unaffected by air delivery and pressure. The power consumption of a propeller blower increases very materially with increase in pressure whereas with centrifugal blowers, the horse power curve rises rapidly with decreasing resistance. As in very few installations the required pressure is known exactly before hand, it is necessary with electric driven machines to select motors with ample reserve capacity to prevent overloading and subsequent burning out of windings. Coppus Vano Blowers, consume practically the same power with entirely closed outlet or discharging freely into the atmosphere.

For forced draft installations on automatic stokers, at the present time usually a large engine, turbine or motor driven fan is used, discharging in an air chamber sometimes common to a number of stokers. From this wind box the air is conducted through individual ducts to the different stokers or stoker compartments.

A large central fan naturally runs at a slow speed which requires, in case of electric motor drive, reduction gears. On account of the above reasons, such an installation is very expensive.

For power plants with continuous operation, a complete second unit has to be provided for reserve. To illustrate this point, we will assume the maximum air requirements for a stoker are 100,000 cubic feet per minute and to make the operation of the plant entirely reliable, 120,000 cubic feet of air would have to be installed in case large central fans are used.

Six No. 500 Coppus Vano Blowers delivering 20,000 cubic feet of air each into a common wind box will do the same work more effectively at far lower initial cost and with increased dependability of operation. For maximum air requirements, five blowers will be in service and in case the plant does not work at maximum capacity for twenty-four hours a day, four or three machines may supply sufficient air during a large part of the day whereas the other machines are standing idle and do not use any power. The sixth machine is kept as a reserve unit. To get a reduced capacity with a large central fan, the driving unit operates at lower efficiency.

In case of a break down of one of the blowers, the necessary repairs are easily accomplished in an hour's time if only a few spare parts are kept in stock. Repairs to a large central unit may easily require several days, thus the installation of six blowers delivering 120,000 cubic feet per minute will secure the highest dependability of operation.

THE WILMON VACUUM TRAP

The novel vacuum trap shown in the illustration, was first perfected during the war and applied in marine service on the S. S. Leviathan by the then Chief Engineer, Commander Vaughan V. Woodward, U. S. Navy, as a means for draining the two low pressure turbines, replacing the customary main air pump drainage of these two large engines.

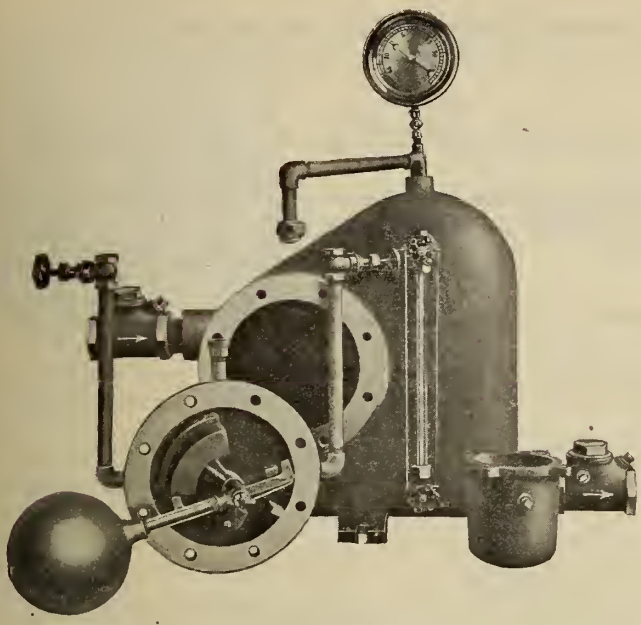
The trap is also suitable for draining apparatus and systems using steam under vacuum, such as condensers evaporators, vacuum pans, cooking kettles, etc., and for returning condensation of live steam heating systems to the boilers. Its use in place of a float controlled condensate pump is often practical and with a consequent elimination of the steam requirement for operating the pump.

The Wilmon Vacuum Trap, as it is called, can also be used for lifting, and when equipped with a counting device, it will perform the additional function of a meter and with greater precision.

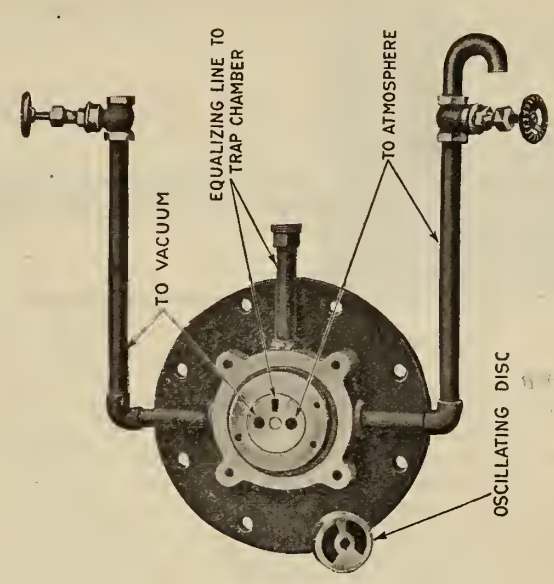
Typical drainage of a steam turbine with the delivery of the condensate at a higher point of discharge is shown in the line cut. In marine installations, where the common practice is to drain the turbine directly into the main air pump, hot vapors must enter the air pump during a part of the time and thereby impair the vacuum. By the use of the Wilmon Vacuum Trap the turbine drains can be removed entirely from the main air pump and placed through the trap into the condenser, thereby insuring that no hot vapors enter the air pump to interfere with the vacuum.

With the exception of the cover bolts, this trap has but thirteen parts, and by removing eight tap bolts, the entire working mechanism, mounted on a flange, can be taken out as a unit.

A compound pressure gauge on top and a sight glass on the front, give a double check on the operation of the trap. Where a permanent record of the



Trap with cover and float mechanism removed.



Showing controlling mechanism.

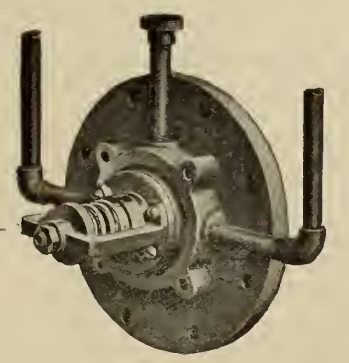
operation of the trap is desired, a recording gauge with electrical contacts may be added.

The receiving chamber of the trap is under vacuum while the water is collecting in the trap, and under atmospheric pressure during discharge. Back flow is prevented by check valves on the inlet and outlet lines.

Change of pressure in the receiving chamber from vacuum to atmospheric and vice versa, is accomplished by an oscillating disc covering three ports, which makes a quick shift from one operating position to the other. One of these positions connects the receiving chamber with the vacuum system, and the other position connects the chamber with the atmospheric line, the communication being effected in both instances through the equalling line which connects the middle port to a top opening in the receiving chamber.

The disc and thrust bearing, and the spring which holds these parts in place are in a separate outer chamber, where they are never in contact with the liquid within the receiving chamber. The disc is operated by a level float, hammer weight and rocker arm, all on the same shaft and located within the receiving chamber.

Water entering the receiving chamber carries the float upward as the level rises, and a contact point on the float stem, between the float and its fulcrum, rotates the weight, until as the latter passes dead centre, it drops onto the contact point on the rocker arm and partially rotates the oscillating disc to the opposite position. This shuts off the vacuum line and opens the receiving chamber to atmospheric and equalizing lines. Water is then forced through the trap outlet, if the latter is connected to a vacuum, or drains by gravity if connected to atmosphere. As the float falls with the water level, the contact point beyond the fulcrum on the float stem lifts the weight past dead centre and lets it drop in the opposite direction, when it hits the opposite end of the rocker arm and shifts the disc. This cuts off the atmospheric line, connects the vacuum and equalizing lines and brings the receiving chamber under vacuum again. The cycle repeats at a



Disc and seat showing controlling parts and operation

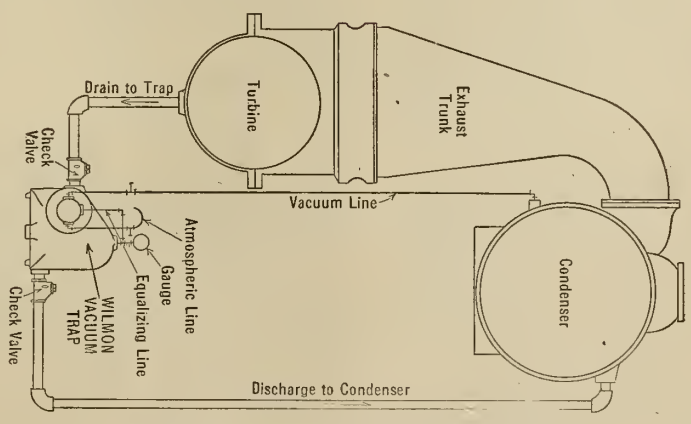
rate determined by the amount of water accumulating. More than three discharges per minute have been obtained with perfect action. The disc requires no adjustment either before trap installation or during service, but may be seen and reached while the trap is in operation, without in any way interfering with the trap action.

The absence of liquids at the controlling ports permits salty or alkaline water to be handled without fear of salting or eroding the operating mechanism.

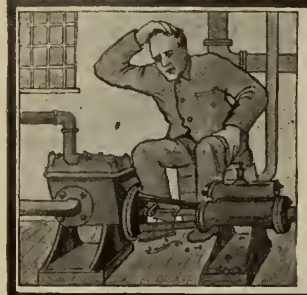
The fact that the liquid passes through no restricted passages gives the trap a very high capacity, which is limited only by the size of the inlet and outlet openings of the trap. The 2-inch trap, for instance, handles 1800 to 2100 gallons of water per hour. This capacity will vary depending on the lift of the discharge.

The Wilmon Vacuum Trap is manufactured by P. H. Gill and Sons. Forge and Machine Works, Brooklyn, N. Y.

Watson & McDaniel Philadelphia have issued a bulletin describing their Watson Single Seat Pilot Operated Reducing Valve, for steam or air service. The bulletin is well illustrated and a detailed description of the valve and its operation is given.



Showing method of draining a steam turbine into a condenser above the turbine.



OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

TEMPERATURE OF COMBUSTION

Question:—What should be the lowest temperature in a furnace when combustion is taking place?

Answer:—It is rather difficult to say what could be the lowest temperature in a furnace when combustion is taking place. For instance when a fire is banked, combustion is taking place, although slowly, and the temperature of the furnace except just over the fire that is banked may be very little higher than the stoke hold atmosphere. The temperature of the fire when in full working condition will again depend on the amount of excess air being supplied. The theoretical temperature of combustion is never reached in actual practice, due to the varying conditions obtaining in the furnace. The following formula gives the approximate temperature that should be reached in an ordinary furnace.

Let C, H, O and W represent the percentages of Carbon, Hydrogen, Oxygen and water in a fuel, and F the pounds of dry gas per pound of fuel then the theoretical temperature T above the atmosphere will be (Kent)

$$T = \frac{616C + 2220H - 327O - 44W}{F + .02W + .18H}$$

Take coal of 77 per cent. carbon, 3 per cent. hydrogen, 3 per cent. oxygen, 3 per cent. water, and the dry gases per pound of fuel being 22 then

$$T = \frac{616 \times 77 \times 2220 \times 3 - 327 \times 3 - 44 \times 3}{22 + .02 \times 3 + .18 \times 3}$$

$$T = 2344.2$$

and supposing the boiler room atmosphere to be 60° the theoretical temperature would be 2404 degrees. Now if the excess air was 200% instead of 100% the temperature theoretically would be only one half or about 1,200, while practically it might drop to 700 degrees. Even under the best circumstances the theoretical temperature is never reached.

STEAM CONSUMPTION

Question:—An engine having a cylinder 14 inches x 36 inches, running 100 revolutions per minute, with a piston rod 2¾ inches dia., and 5% clearance. The terminal pressure is 53 pounds per square inch gauge. What is the consumption of water per horse power per hour, if the engine is 75 h.p.?

Answer:—Assuming that the compression is carried out in the usual manner we can neglect clearance, and assume that the cylinder is full of steam at the terminal pressure when exhaust opens.

The volume of the cylinder will be

$$\frac{14 \times 14 \times .7854 \times 36}{1728}$$ cubic feet, and the area of the piston rod can safely be neglected in a calculation like this. The weight of a cubic foot of steam at a gauge pressure of 53 lbs. will be .1569 lbs. then the weight of steam in the cylinder will be

$$1.16 \times 1.16 \times .7854 \times 3 \times .1569 = .497 \text{ lbs.}$$

say ½ lb. steam per stroke, and 200 strokes per minute gives 100 lbs. per minute and 6000 lbs. per hour.

The horse power of the engine would be with a terminal pressure of 53 lbs,. and a ratio of mean to terminal pressure of 1.7 giving a m.e.p. of 53x1.7= 90.1

$$\frac{14 \times 14 \times .7854 \times 90 \times 3 \times 200}{33000} = 252 \text{ H. P.}$$

and with 6000 lbs. steam per hour the consumption would be 23.8 lbs. per I. H. P. per hour.

If we take our correspondent's figure of 75 H. P. the consumption would be 80 lbs per I. H. P. per hour.

SAFETY VALVE SPRINGS

Question:—A boiler has two safety valves each 3½ inches diameter. The size of the spring wire is ⅝ inches square. What should be the allowable pressure on boiler, the grate surface, the diameter and length of spring.

Answer:—We are compelled here to assume at least one factor. We can find the grate surface from the area of the valve, and we can find the load on the valve either by assuming a spring diameter or by assuming a pressure per square inch and then finding the spring diameter.

If we take our correspondent's figure

$$\text{of } A = \frac{37.5 \times G}{P}$$

where A is the area of valve, G the grate surface, and P the gross pressure we can find the grate surface if we know the pressure, or find the pressure if we know the grate surface. The area of the valves will be 9.6 x 2=19.2 square inches, and if we assume a pressure of 140 lbs. absolute we get

$$G = \frac{19.2 \times 140}{37.5}$$

$$G = 71.6$$

The load on one spring will be that due to the pressure on the area of the valve or

$$9.6 \times 125 = 1200 \text{ lbs.}$$

Now one formula for the spring of a safety valve is

$$d^3 = \frac{S \times D}{C}$$

where d=diameter or side of wire
S=load on the spring in lbs.
C=11,000 for square steel
D=mean diameter of spring.

Then we can substitute and find the diameter of spring from what we have already. Thus

$$.625^3 = \frac{312000 \times D}{11000}$$

$$D = \frac{11000 \times .625^3}{1200}$$

$$= \frac{110 \times .244}{12}$$

$$= 2.237$$

That is a mean diameter of 2.237 or we might make it 2.25 in round numbers.

The compression of the spring depends on the fourth power of the size of wire, and cube of the mean diameter, and the number of coils.

The formula for compression is

$$f = \frac{D^3 x S x n}{f^4 \times a}$$

where f=compression of spring
D^3=mean diameter
n=number of cards
f=thickness of wire
a=2,000,000 for square steel.

We have the mean diameter, thickness of wire, and the constant a. Suppose we wish to have a compression of three inches to give the load then

$$3 = \frac{(2\frac{1}{4})^3 \times 1200 \times n}{(\frac{5}{8})^4 \times 2{,}000{,}000}$$

$$n = 8.3$$

This gives us 8 coils, not counting the two scarfed coils at each end, which are not free.

If we have 3 16″ between each coil when the spring is compressed, and there are 8 free coils this will be 1 5 16 space, and 9 x ⅝ is 4⅝, so that the height of the spring will be 5 15 16 when compressed, or 8 5 16 when free. The outside diameter will be 2⅞ inches.

The Operators' Point of View

HOME MADE FORCE HAND OR POWER OIL PUMPS

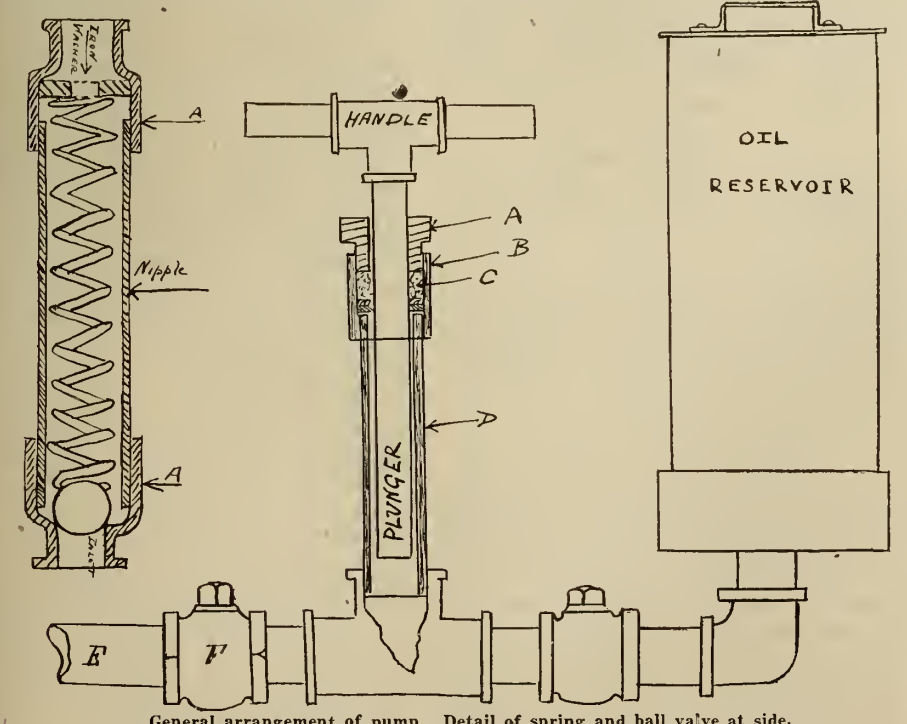
James E. Noble

A friend wanted a one quart size oil pump and upon inquiry he discovered the price to be from $9.00 upwards. The man who paid him his salary refused to invest this amount so the friend collected some pipe fittings and put them together in the shape shown in the sketch. I will not give any dimensions as the pump can be made any size with a ¼ inch plunger upwards. A is a bushing, B is a coupling, C is packing , under the packing is shown two iron or other metal washers, they prevent the packing working down into the cylinder D, which is a piece of plain iron pipe, it does not require a finished inner surface as the plunger is a very loose fit, the iron rod plunger should be made as smooth and true as possible on account of the tight joint necessary at the packing.

F and G are check valves. E is the discharge. The oil reservoir can be tin or galvanized sheet iron. The sketch shows a piece of large pipe with a bottom cap tapped to take the nipple, an ordinary tin cover on the tap.

As shown it is hand operated but the tee can be removed and a proper attachment used if it is desired to operate it by power. The reservoir can be set up on a shelf if the user would rather have it there, if the conditions are such that the oil will not flow out of the reservoir by gravity when the oiled machines are not operating.

Oil can be prevented from running from the reservoirs by gravity by adding a cut off valve between check valve G and the elbow, or a spring loaded valve can be used instead of check valve F. It is not difficult to make such a valve. Fig. 2 will give an idea for a home made one. A being reducing couplings, B. an iron or brass washer to hold the end of the spring, C the closing valve, consisting of a round ball, a nipple is between the couplings, a long thread being on the ball end. The inlet of course is at the ball end.



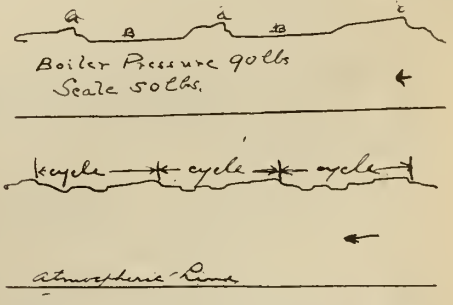
General arrangement of pump. Detail of spring and ball valve at side.

STEAM PRESSURE BOILER FEED PUMPS

By R. McLAREN

"In boiler-feed pumps the steam pressure available and the pressure pumped against are practically equal, so that it might be expected that the area of the steam piston would be made about 40 per cent. larger than the area of the water piston. In actual practice it is found, however, that pump manufacturers prefer to make the steam piston about three times the area of the water piston in very small pumps and about twice the area of the water piston in large pumps. The steam piston of boiler-feed pumps is made so largely in excess of what it really needs to be merely as a matter of safety; its large size simply tends to insure a prompt starting of the pump under almost all conditions likely to arise in practice."

With the above in mind I was curious to know what pressure there would be in the steam chest and therefore throughout the entire stroke of a duplex, direct acting, outside packed plunger pump whose steam piston is 7½ inch in diameter, water plunger 4½ inch in diameter and stroke 10 inch. The pump is controlled by a pump governor of a type designed to maintain a constant pressure in the feed line. An indicator was attached to the steam chest cover and by drawing the cord



Indicator diagram from pump steam chest.

out slowly and steadily while pressing the pencil to the paper, a chart was obtained showing the pressure in the chest over a period covering several cycles. A 50 lb. spring was used and it will be seen that at no point was the pressure up to 50 lbs. in the chest although it was close to it. Fig. 1 is the chart. The boiler pressure was 90 lbs. and the pressure in the feed line 110 lbs.

With the throttle closed so that the pump would move very slowly, Fig. 2 was obtained.

The governor was not by-passed, the steam having to pass through the governor and the partly closed throttle. At the points a a a the speed accelerated. At points B B the pump was apparently stuck. Can anyone explain why the pressure did not rise at points B when the pump was not moving?

CHART FOR PIPING

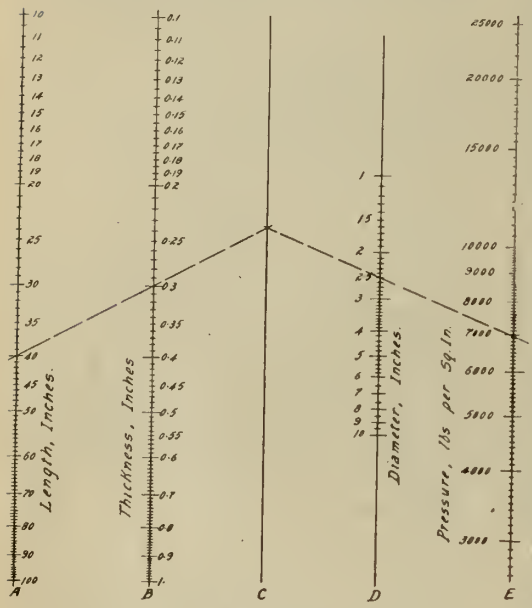
W. F. Schaphorst

The chart shown in the accompany illustration is one which is based on the formula that

$$P = 9{,}600{,}000 \frac{T2.18}{LD}$$

where P=the collapsible pressure in lbs. per sq. in.
T=thickness of metal in inches.
L=length of pipe in inches.
D=outside diameter of pipe in inches.

The chart is intended for solving piping problems without need of calculations, by the simple use of a straight edge as shown by the dotted lines.



Example — What external pressure will a 2.5 inch pipe safely with stand whose length is 40 inches and the thickness is 0.3 inch?

Run a straight line through 40 (col. A) and the 0.3 (col. B) and locate the intersection on Col. C. From this intersection run a straight line through 2.5 (col. D) and the intersection with col. E gives the result. In this case, 6950 lbs. per sq. in. The chart can be used to obtain any of the other factors by simply reversing the process.

VENTILATION RESEARCH

The Pittsburgh Experiment Station of the United States Bureau of Mines is working in co-operation with the Research Bureau of the American Society of Heating and Ventilating Engineers on a number of important problems which affect each individual in his home life, in his place of business, and especially in those places where many people congregate, as in churches, schoolrooms, and theaters. It is important to ventilate such places with sufficient fresh air to make everyone comfortable enough to be able to work at high efficiency. The circulation of excessive quantities of fresh air imposes a considerable cost on the heating system therefore an efficiently designed heating and ventilating system introduces the least amount of cooled air consistent with proper conditions for health. In this connection the use of ozone has frequently been proposed and actually tried in a number of places. The ozone is supposed to deodorize and purify the air by the oxidation of organic matter and possibly by killing bacteria.

It is however, a real question as to whether ozone can be introduced in quantities large enough to kill bacteria without producing very serious irritation of the throat and lung tissues. It is also a question as to whether harmful oxides of nitrogen are not produced simultaneously with ozone. Definite information is needed on this subject. The first step in obtaining such information is to work out methods for accurately determining the percentage of ozone and oxides of nitrogen produced for different types of ozone machines and to develop suitable methods for determining the very small quantities of ozone and oxide of nitrogen that may be in the air treated with such machines. Analytical work of the highest precision is required. The gas laboratory of the Bureau of Mines, Pittsburgh Station, is now engaged on this problem, working in co-operation with the Research Bureau of the American Society of Heating and Ventilating Engineers which is housed in the same building.

After the chemists have worked out the methods of detecting and analysing these small quantities of ozone and oxides of nitrogen, the next problem will be undertaken in a like co-operation of the two agencies just named working with the United States Public Health Service. Surgeons from this service are detailed to the Bureau of Mines for working on health and sanitation problems. The work is being carried on under the joint general direction of A. C. Fieldner supervising chemist and superintendent of the Pittsburgh tation of the Bureau of Mines, and Dr. R. R. Sayers, chief surgeon, Bureau of Mines, by G. W. Jones, assistant gas chemist, Bureau of Mines; W. P. Yant, assistant analytical chemist, Bureau of Mines; and O. W. Armspach, engineer, American Society of Heating and Ventilating Engineers.

WHY SAFETY WORK

We would like to think, perhaps, that the accident-prevention campaigns that have been conducted in our industrial establishments have been carried on for purely humanitarian reasons. Some of them certainly have had such a basis, and the number may be greater than any if us would be likely to guess. But in all cases it is, in addition, "good business" to maintain effective safety work,—whether that fact is recognized or not. Accident prevention is distinctly profitable, and if conducted in an efficient manner it yields big dividends on the investment.

The actual cash return from safety work is hard to determine, but that does not prove that there is no return and it does not prove that the return is small. It is almost equally hard, in many cases, to trace the actual cash return made by advertising, yet nobody questions the soundness of rational advertising as a business investment.

Some idea of the cash saving brought about by accident-prevention work may be had, by figuring the actual time lost per year on account of accidental injury. A first-class workman means certain amount of profit per day, and this amount, multiplied by the number of days lost a year on account of accidents, gives the actual loss covered by this one item. Any reduction in the number of days lost therefore means a direct saving in dollars and cents.

But saving is effected in other ways also,—and the additional saving is quite real, even though indirect.

An accident in a workroom upsets the organization by demoralizing the other workmen, and this means time lost. In a bad case a whole department may be temporarily shut down on account of the state of mind of the workers, and standard efficiency may not be again attained for several days. Somebody's time is also lost in caring for the injured man —removing him from the room giving him first aid treatment, taking him to his home, and doing other things incidental to making him as comfortable as possible. All this time must be included in figuring the cost of the accident, if a rational result is to be reached.

Again, a new man must take the injured workman's place, or take the place of somebody else who is shifted to the vacant job. The new man must be instructed by the foreman —which takes the foreman's time; and for a while the man will be below standard in his production —which is another source of expense. Not being familiar with the work in hand, he is likely to spoil considerable material while getting accustomed to the new place—and this is expensive, especially if he spoils pieces upon which other workmen have already spent a measurable amount of time. Moreover, the new man is presumably more likely to meet with an accident himself, than a more experienced man would be; and in this sense he becomes an increased hazard, and possibly a new source of expense.

The cost of an accident does not stop here, however. The injured man must be cared for while he is disabled, and even though this expense may be borne by an insurance carrier, the rate paid for such insurance depends in considerable measure upon the accident-frequency in the plant in question. If the accident-frequency is high, the insurance rate will be correspondingly high, and the insurance premium that is paid is one of the operating costs that has to be included in determining the total cost of production.

Safety work that has been carried on in times past will help in some measure to reduce the accidents of to-day.

but it must be remembered that although adequate safeguards may have been installed throughout the plant, the major part of the industrial accidents that occur are caused by factors against which mechanical safeguards provide little or no protection.

After the physical hazards are guarded, suitable action must be taken to see that the guards are constantly kept in place and are maintained in first-class condition. It then remains to protect the men from carelessness, lack of judgment, ignorance of existing dangers, and other factors entirely dependent upon the human element. This work can be done only by safety education, continuously carried on by an active organization;—which means that to keep industrial accidents at a minimum, safety work and accident-prevention campaigns must not be interrupted.

Statistics for the year 1920 show gratifying results in connection with safety activities in our various industries, and there is every indication that systematic safety work, in plants where it is being carried on, is producing positive and valuable results in the way of reducing the total number of accidents in industry in general. The good work that is being done in the establishments that are actively prosecuting it, is reducing accidents faster than they are increasing in other places where such work has never been instituted, or where it has been suspended for one reason or another. But that is not enough. Rational safety work actually shows a profit by reducing the costs of production, and no enterprising business man should be willing to give it up, any more than he would think of stopping his advertising or annulling any other factor in his business that has been proved to be a source of revenue. Men who have thought best to discontinue such work for the time being have probably failed to appreciate the indirect costs that such discontinuance introduces, and have centered their attention solely upon the more immediate and obvious items on the cost side of the ledger. Good safety work should be the last activity suspended, because it returns a profit (all things considered) which is it at least as great, in most cases, as the ordinary profit yielded by the business as a whole under normal conditions.—Travelers Standard.

WELDING BY CLOCKWORK

In shipbuilding and in many engineering operations, it is necessary to fix brass studs and other small parts to iron plate. This operation is usually performed by drilling holes in the plate, each hole being drilled separately. By means of a most ingenious invention recently perfected by a British firm, the process is carried out in a few seconds by electric welding. The working of the machine is almost entirely automatic from the moment the stud is placed in position. Each size of stud requires a different time for welding it to the plate, and the machine can be set to give exactly the period required to make a perfect weld. The tests which have been made proved that the machine is able to weld 120 brass studs within the hour. It might be thought that welding does not give such a firm arrangement as screwing the stud into a hole in the plate, but when the welded stud is hammered the brass will break before the weld yields. Another advantage of the machine is that work can be satisfactorily carried out by semi-skilled labor.

POWER FROM SEWAGE

It is often said that modern methods of sewage disposal are exceedingly wasteful, because they throw away material, which might be utilized to great advantage. Many of the systems developed in Great Britain are free from this reproach, and experiments recently made in the utilization of gas from sewage show that in an unexpected quarter British engineers are attempting to secure the highest economy. In one large British city a gas plant was installed to give 25 horse power for a working period of six hours per day. It is driven by gas generated from the dry solid matter produced in the process of sewage disposal. The experiment has been most promising, and it has revealed a useful source of power in a district where gas and electricity are not available. The power produced by the sewage gas is used to drive the plant which forms an essential part in the installation for purifying the sewage; thus it affords a most desirable form of economy.

BUSINESS MEN GIVEN GOOD ADVICE

In Mr. O'Connor's opinion, the business man of to-day is confronted with the option of sitting down to wait for the clouds to roll by, or to get up and push those clouds away. Mr. O'Connor is general manager of the Murray-Kay Co., Toronto, and the above remarks were given a few days ago in an address before the Lions' Club at Toronto. Among many other thing things he said, that manufacturers cannot put their spare money into tax free bonds, then go out and play golf or something else, and think that is going to save the situation.

"Such a plan is so ephemeral, and so obviously not the solution to any country's financial problems," remarked Mr. O'Connor, "that I am surprised that men who have built fortunes for themselves can become converts to it. Capital cannot exist in a strong box. The only place that capital can keep its life is out in the open. Nothing would be more fatal to any community than the common adoption by all who had savings of such a plan."

THINKING ENGINE IS TESTED CAREFULLY

In our editorial columns this week we speak of the "thinking" locomotive. This device automatically prevents railway collisions and nearly all sorts of railway accidents. The mechanism is controlled by electricty running at a very low voltage through the rails. The railway is divided into insulated sections of suitable lengths and the locomotive is provided with an induction coil placed two inches above the tracks. This "picks up" the current which, transformed into a higher power, magnetically sustains a weight in the engine cab. This weight, if dropped, will act on the locomotive's mechanism and bring it to a standstill, But the voltage is so low that it is sufficient for only locomotives and hence if two approach each other the current becomes insufficient and the weight drops, causing first a blowing of the whistle, second the shutting off of the steam, and third, application of the brakes.

Does not Depend on Human Element

It is stated that the installation of the new system on eight lines in England will begin immediately. The system operates even if the engine driver is drunk or asleep. The human element is only on the mechanic who controls the supply of current to the locomotives, but the worst that could happen from his carelessness would be a momentary suspension of the traffic.

Mr. Angus the inventor, claims that his system will greatly increase the safety of moving traffic on congested lines. Its novelty is the absence of any "shoes," "clamps," or other mechanical contacts which it is claimed have made all previous systems unsatisfactory. Finally Mr. Angus claims that the system is very economical; in fact he purposes to install it on the English railways free of charge, taking as his profit half of the resultant saving in the operating costs.

D. K. Chadbourne has been appointed Manager of the New York Office of the Westinghouse Electric International Company. Mr. Chadbourne came to the Westinghouse Company through the George Cutter Company before it was affiliated with the Westinghouse, as he was successively western district manager and eastern district manager of the latter company from 1912 to 1920, when he joined the Westinghouse Electric International Company.

The Conveyors Corporation of America have issued a bulletin describing the American air tight doors, which have been designed for service where a non-warping, airtight door is a necessity. Some of these places are ash-pits, boiler settings, coke ovens, oil stills, kilns, retorts, etc. The doors are used in connection with the steam jet ash conveyor made by the company.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	
1¾-in.	29 75	
2 -in.	29 25	19 00
2½-in.	44 75	22 50
3 -in.	49 25	27 50
3¼-in.	.....	34 00
3½-in.	63 50	30 50
4 -in.	85 00	40 00

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$4 25	$3 90
Plates, ¼-in. up	3 75	3 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.99	20.13	19.90	24.04
1½	19.19	24.06	23.79	28.74
2	25.72	20.13	32.01	38.67
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.

4½-in. and larger, 40%.

4-in. and under, running thread, 20%.

Standard couplings, 4-in. and under, 20%.

4½-in. and larger net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ....base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15%
Standard	15 to 40%
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	21	Atlas	19
Peerless	22	X Empire	15
Grand	21½	Ideal	18
Superior	21½	X Press	13½
X L C R	16½		

Colored

Lion	13½	Popular	10½
Standard	12	Keen	9
No. 1	14		

Wool Packing

Arrov.		Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20	Dark colored.	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	34 00	$39 00
Spelter	7 25	7 50
Lead	6 50	7 50
Antimony	7 25	8 25
Aluminum	28 00	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.

Cut sheets to size, 1c lb. extra.

Canadian Association *of* Stationary Engineers

Incorporated May, 1887
Incorporated at Ottawa June, 1917

This Organization is founded on the following principles:

—The better education of its members in the science of steam engineering.
—To protect the competent engineer and his vocation.
—To enroll all competent engineers in this organization.
—To impart information beneficial to the profession.
—To assist members out of employment to obtain the same.
—To procure by legal enactment greater safety in the operation of steam plants.
—The belief that knowledge and ability of one's profession is what is necessary to make success possible.

Brother Engineer:

Did it ever appeal to you to join an association devoted entirely to the interests of the engineering profession; one which by means of lectures, illustrated and otherwise, delivered in the lodge room, tends to keep its members right up to the minute with the progress made in the engineering professions?

If you are interested in an association of this kind, and live where less than fifteen engineers reside, send for a copy of our constitution, and make application to the nearest lodge for membership. If you live where more than fifteen engineers live, get together and send in a written application to me.

The undersigned will be very pleased to give any further information required.

F. HARPER, President Grand Lodge.
89 Bay Street, Kingston.

L. J. ELLIS, Sec.-Treasurer Grand Lodge.
142 East Avenue, N. Hamilton.

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Great Industries standardize on Tycos Temperature Instruments because built upon two basic factors—the Dictates of Science—the Requirements of Industry.

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Repairs now handled efficiently, quickly, and economically in Canada.

Taylor Instrument Companies

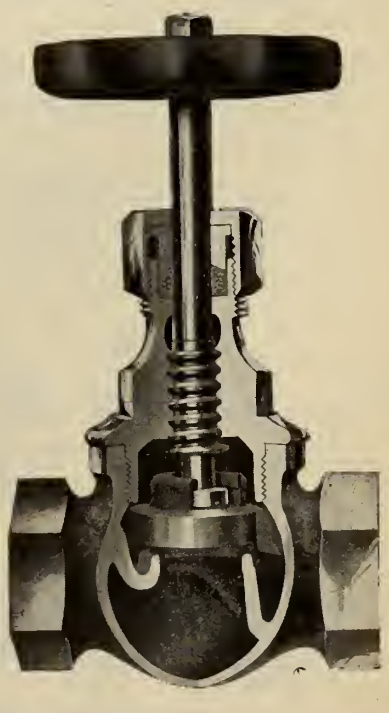
110-112 Church St., Toronto, Ont.

There's a *Tycos* and *Taylor* Thermometer for every purpose

751½

Fairbanks-Morse Valves

Reduce Maintenance Costs



A new disc can be put on in one minute without removing the valve from the pipe line.

The main features of this valve are:—

Stuffing box packed with Palmetto Twist packing.

At least four threads engaged with bonnet at all times.

Renewable Bakelite Disc can be replaced in one minute.

Raised round seat. No sediment can lodge on it to injure disc.

Guides cast on body hold disc centrally over seat.

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

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Cut No. 12.

Belliss Triple Expansion Engine and Alternator

BELLISS & MORCOM, Ltd.

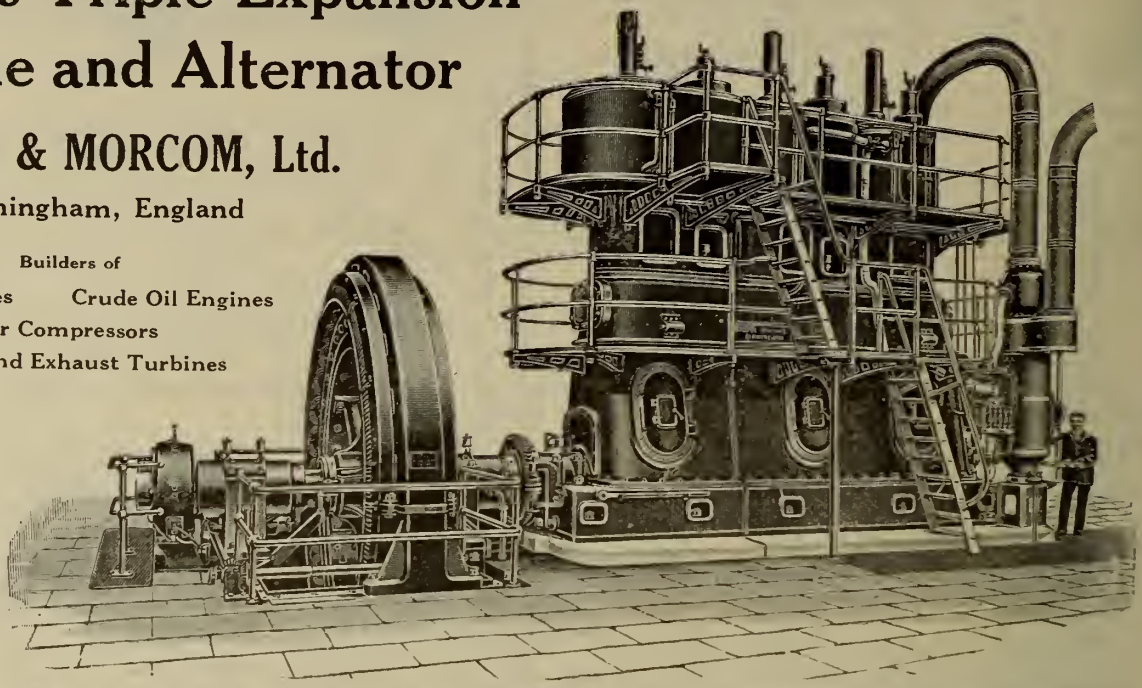
Birmingham, England

Builders of

Steam Engines Crude Oil Engines

Air Compressors

Steam and Exhaust Turbines



Agents:

LAURIE & LAMB

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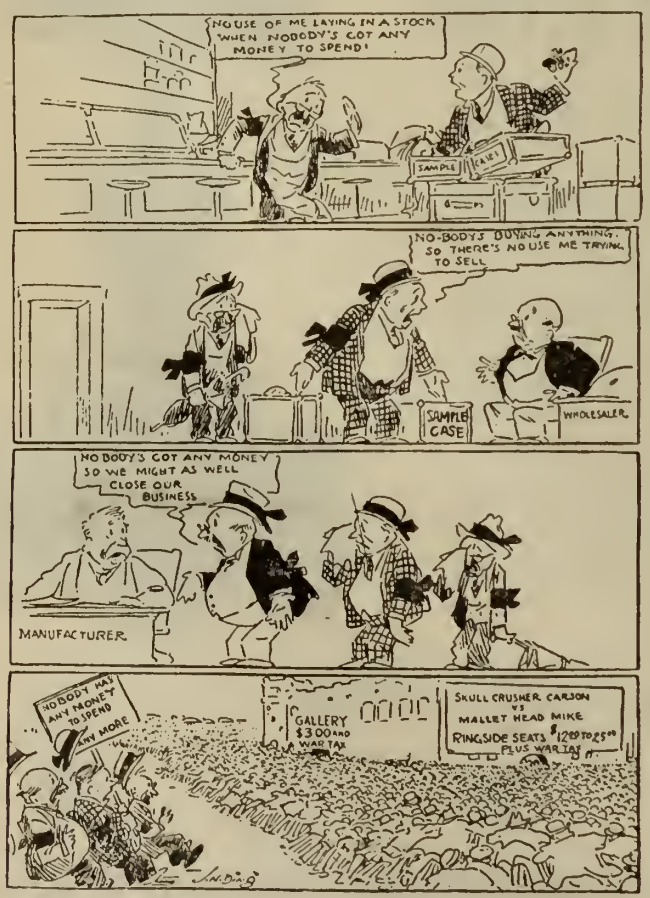
MONTREAL


NOUSE OF ME LAYING IN A STOCK WHEN NOBODY'S GOT ANY MONEY TO SPEND!
SAMPLE CASE
NO-BODY'S BUYING ANYTHING. SO THERE'S NO USE ME TRYING TO SELL
SAMPLE CASE
WHOLESALER
NO BODY'S GOT ANY MONEY SO WE MIGHT AS WELL CLOSE OUR BUSINESS
MANUFACTURER
NOBODY HAS ANY MONEY TO SPEND ANY MORE
GALLERY $3.00 AND WAR TAX
SKULL CRUSHER CARSON VS MALLET HEAD MIKE
RINGSIDE SEATS $12.00 TO $25.00 PLUS WAR TAX

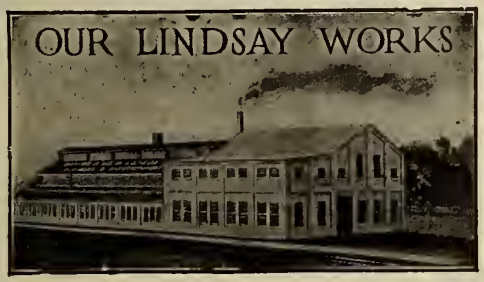
The True Value of Work

SPEAKING ON "Work" the college paper, "The Varsity," gets away with these choice and true remarks:

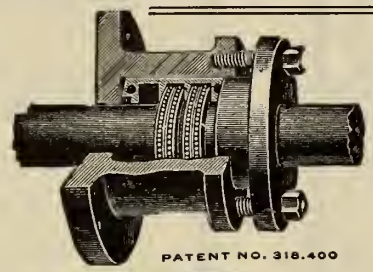
After all, why should we work? Why spoil one's College course by going to lectures, and by plugging hour after hour at the writings of men who are dead and gone—we know where we should have sent them—when there are so many other activities that claim one's attention and interest? What's the use of it, when we know that a kind-hearted Providence has endowed one with brains enough to get over the year's work in the last six weeks and still get a very respectable third, or even a second? How often we reason thus, not so much at this time of year as later in the session. How ready we are to accept the old interpretation of the Genesis story and believe that Work was sent as a punishment for man's sin and that Heaven is a state of rest in which our tasks are all done and done with. It is well that at the outset of our year we should realize the fallacy of this view of Work. The Pauline dictum, "Let this be known among you, that if any man will not work neither shall he eat," is not only sound theology, but is also sound economics. Work is not an imposition, but a duty and a privilege, and the man who does not appreciate the fact that without real work his personality cannot gain full play, is indeed unfortunate. It is all right to work for a degree. It is better to work for the knowledge gained, but above all it is good to work for work's sake. The greatest happiness is the knowledge of a congenial and useful task well done and the prospect of another to be done.

HINTS TO BUYERS

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario



PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	893,066
" "	775 193	" "	905,10b
" "	775,194	" "	834,629
" "	791,300	" "	979,206
" "	805,669	" "	1000.76

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

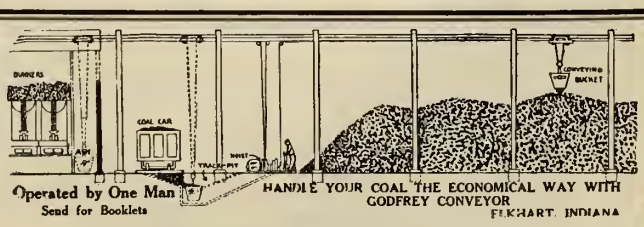
HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.
Incorporated 1897

Don't wait—Do it now

Reserve space for our

DIRECTORY NUMBER

November 20th Issue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Operated by One Man
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HANDLE YOUR COAL THE ECONOMICAL WAY WITH GODFREY CONVEYOR
ELKHART, INDIANA

GODFREY CONVEYORS
Save Time, Labor and Money

In unloading cars and handling coal, coke, ashes, sand, gravel and similar materials.

Send for descriptive catalogue No. B-1.

M. A. KENNEDY, Limited
106-110 Richmond St. West, Toronto, Canada.
GODFREY CONVEYOR COMPANY
124-147 Thirteenth St. - Elkhart, Indiana, U.S.A.

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

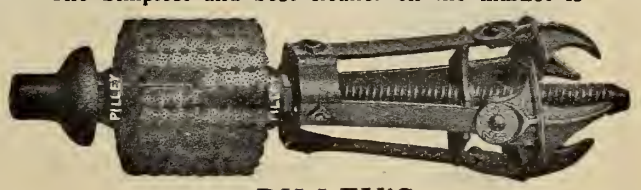
Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
26 Craig Street - MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap

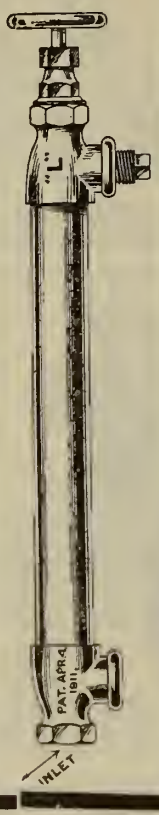
Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admissions of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds. Being open at starting, it cannot become air bound, this doing away with air cocks or vents—Does Not Freeze.

It is capable of draining from 900 to 1,500 feet of one inch pipe.

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to



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If your dealer does not sell it, write direct. No. 2

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TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

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ENGINEER—HOLDING ONTARIO CERTIFICATE, thoroughly experienced in refrigeration and electricity is open for position. Box 17821 Power House, Toronto. P. 4. H.

WANTED—SITUATION AS GAS ENGINEER for producer or city gas, gasoline or kerosene engine. Preferably for small electric light plant, able to do own repairs, climb poles and do own wiring and take full charge. Apply Box 31821, Power House. p.2.h.

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EXPERIENCED MACHINIST WITH ENGINeer's certificate, good at general repair work desires position. Apply Box 14921 Power House, P2H

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WE BUY IDLE EQUIPMENT OR MACHinery; call or write, mentioning Power House. H. W. Petrie, Ltd. Toronto.

MACHINERY FOR RENTAL — WE WILL rent by the month motors, hoists or contractors' plant of any description. Apply, mentioning Power House, H. W. Petrie, Limited, Toronto.

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Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

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TWENTY-FOUR PER YEAR

TWO DOLLARS

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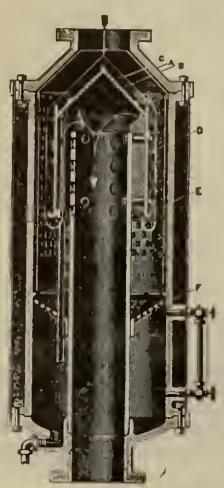

Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's Separators

DIRECT SEPARATOR COMPANY

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General Sales Agents

Canadian Fairbanks-Morse Company, Limited

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In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing and our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING CO., WINDSOR, ONT.

In Cotton Tubes

Jenkins Valves

"I Know It's Good Because It's a Jenkins!"

The experienced engineer—the man on the job—knows the significance of the name Jenkins within a Diamond Mark cast upon the valve body.

He knows that it stamps the valve as a genuine Jenkins—that it assures quality metal in the construction, correct proportion at every point and long lasting, trouble-free service under the most severe conditions of usage.

Jenkins Diamond Marked Valves are made in types and sizes to meet every requirement of service everywhere. Every Jenkins Valve is *tested for maximum service before it leaves the factory.*

Copy of No. 8 Catalog (free on request) shows how very complete the Jenkins line is. Write for it to-day.

Jenkins Bros.

TRADE JENKINS MARK

LIMITED

TRADE JENKINS MARK

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AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

Jenkins Bros. Jenkins Bros.

Let's Get Down to Business

SUMMER, with its dog-days, its vacations, its distractions, is over. We have had our holidays, our rest, our recreation. The Fall season, with its new opportunities for effort, enterprise and achievement, is upon us. Let us rip off our coats and get down to business. We may have allowed pessimism to grip us during the stagnant months of Summer. We may even have allowed laziness to enter our blood and our bones. It is now up to us to throw off both lassitude and pessimism. The time has come for action, for aggressiveness, for enterprise, for courage, for daring. Strong men make opportunities. Strong men do not supinely submit to conditions; they mold them. The business roadway has been cleared of almost all the weeds and rocks and swamp; begotten by the fatal war boom. The way is now open for a vigorous forward march. Let us cease looking backwards, let us cease bemoaning the hardships and the distress of the recent past. Let us look forward and let us go forward with confident unhesitating tread. Better times are within our reach if we will but reach out intelligently towards attaining them.—*Forbes.*

Is your packing as good as your flanges?

WHEN you order pipe flanges, you know that they will stand anything the pipe will stand.

Can you be as certain about the packing from which you cut the gaskets to pack these flanges? You know that if a gasket fails, you've lost much more than the few cents premium you might have paid for a better packing. For gasket failure almost always means a loss in time, labor and production that is out of all proportion to the initial cost of the gasket—amounting often to hundreds of dollars.

If you would be sure that your packing will render you the service you have the right to expect, cut your gaskets from Johns-Manville Service Sheet Packing.

Why Service Sheet makes the best gaskets

IN Johns-Manville Service Sheet we have produced a strong, thin sheet packing that resists heat, water and chemical solutions

Gaskets cut from Johns-Manville Service Sheet Packing are reliable because they are made of Asbestos Fibre, bonded with a heat-resisting compound; they practically eliminate joint failure because Service Sheet is not harmfully affected by superheated or saturated steam, air, water, ammonia, oil or most chemical solutions; they are so dense, yet resilient, that they can be used half as thick as compressible gaskets and make tighter, longer-lasting joints.

With Service Sheet, only one sheet packing, instead of several, is required for practically all conditions. This means that the minimum stock may be carried with less chance of using the wrong sheet for particular conditions, yet you need never be afraid to keep an adequate stock on hand because Service Sheet does not deteriorate with age.

Ask the nearest Johns-Manville branch for a sample and the booklet describing Service Sheet.

CANADIAN JOHNS-MANVILLE CO. LIMITED

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JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE
POWER PLANT MATERIALS

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Two 72" x 42 Ft. Pressure Tanks
E. LEONARD & SONS, LIMITED
Head Office and Works: London, Canada. Branches from Coast to Coast
Established 1834

LEONARD

DROP—FORGINGS
often cheaper than castings
—always far superior

WILLIAMS' SUPERIOR DROP-FORGED "Agrippa" Clamps

FOR medium service there is no better clamp made than Williams' "Agrippa".

Drop-Forged from strong, tough, selected steel and heat-treated after forging, there is little possibility of springing. Better tools make better workmen and the best workmen say Williams' "Agrippa" are best.

Seven sizes of 4 inch to 18 inch capacity.

Ask for Machinists' Tools Book which also describes Williams' Clamps for every purpose.

J. H. WILLIAMS & CO., Limited
"The Drop-Forging People"
78 Thorold Road St. Catharines, Ontario

AMERICAN
THOMPSON
IMPROVED INDICATOR

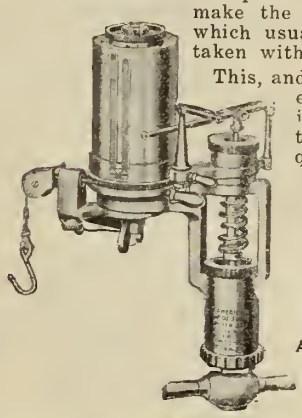
While your engine is running at top speed you can change cards on an American Thompson Improved Indicator in less time than it takes to talk about it.

With our patented design of Detent Motion two or more cards can be taken in the time ordinarily required for one. You don't have to unhook cord, and cord will remain at same tension.

American Thompson Improved Indicator

Is the only make with this Improved Detent Motion. And without this device it is a slow, disagreeable and often difficult task to take off one card and put on another.

The American is also the most accurate Indicator. Because of its limited pencil motion, it is impossible to make the errors in vertical lines, which usually exist in the diagrams taken with other Indicators.



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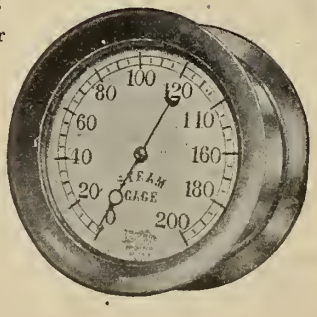

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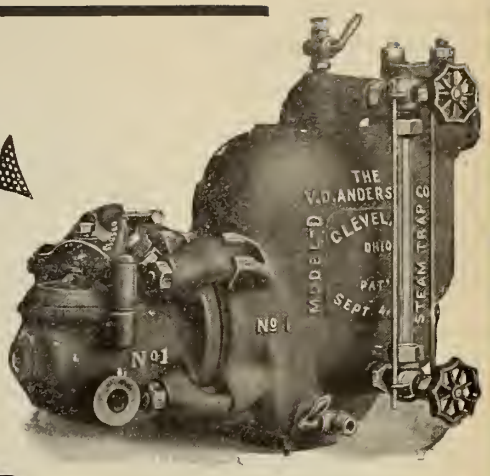
The Anderson
Model "D"
Steam Trap

Built to fit any Steam Line



You can use this trap on any line. Anywhere or everywhere there is condensation the **Anderson Model "D" Trap** will give you economical service. Because it absolutely prevents loss of steam some odd thousands of users are "strong" for this trap. It is the most effective trap because it automatically adjusts itself for any pressure within its capacity. Valves are built of wear-proof, rust-resisting materials. Equipped with a removable strainer which prevents scale, packing, etc., from entering the valve. Ask for catalogue.

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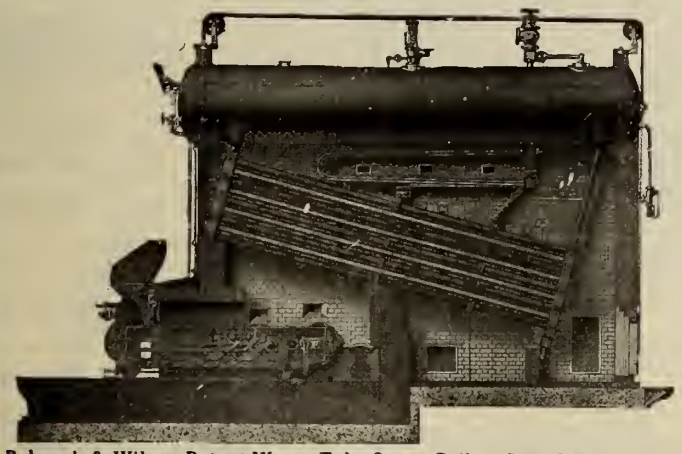
HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE



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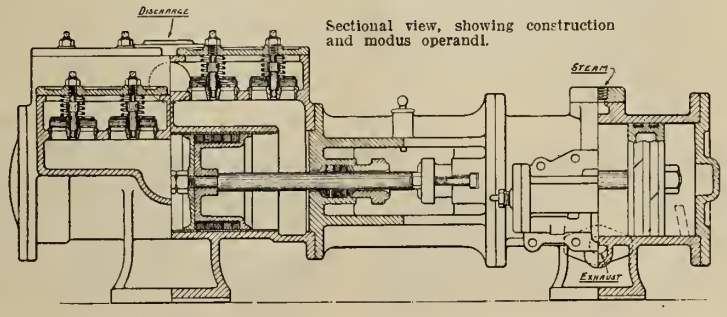

Sectional view, showing construction and modus operandi.

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Self-draining steam cylinders, accessible valves, long strokes, absence of screw threads on valve seats and valve stops—these are the features that engineers appreciate in Hepburn Vacuum Pumps. Send for complete details.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
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COUPLINGS, SHAFT
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CRANES, SWING JIB
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CRANES, WALL
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Lincoln Electric Co. of Can., Ltd., Toronto
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ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd. Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd. Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

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Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
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Sturtevant Co., B. F., Toronto, Can.

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Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

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Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

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Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

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Mason Regulator & Eng. Co., Ltd., Montreal.
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FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

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S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
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FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Dart Union Co., Ltd., Toronto, Ont.
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FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

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Dart Union Co., Ltd., Toronto, Ont.
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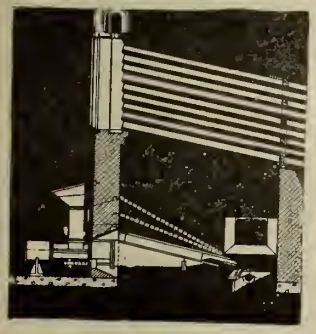
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto Ont

Instead of a crankshaft and a lot of complications, simple self-contained retorts.



Slight slope of Jones "A-C" retort compared with gravity feed retorts (indicated by dotted lines). Instead of gravity fuel movement, positive movement.

Jones "A-C" high side tuyeres (above) compared with ordinary type (below). Increases furnace width; keeps fire and clinker away from side wall.

The simple balanced dump plate easily operated by one man.

Simplicity—without a single sacrifice

The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized as the Under-Feed Stoker Co. of Canada, Ltd., and the reorganization makes available for Canadian Power users the extensive engineering resources of the Under-Feed Stoker Co. of America.

Can you think of any piece of power plant equipment that is taxed as heavily and irregularly as the stoker? You can't expect a complicated, delicately adjusted device to withstand this hard grind—it's like expecting results from a race horse hitched to a plow.

The illustrations here show how the stamina of the plow horse is built into the Jones "A-C" without sacrificing the get-away and speed of the race horse. Or, to put it another way, how quick pick-up and overload capacity are combined with that sterling quality, rugged simplicity, that insures **staying power.** Consider the following exclusive Jones advantages:

Instead of a crankshaft with its connecting rods, shearing pins, gears, sprockets, chains, etc., a simple steam-driven retort with one sturdy moving unit—no moving parts in the fire.

Instead of an erratic gravity feed, a positive mechanical fuel movement. Note the slight slope of the "A-C" retort diagrammed above.

Instead of side wall clinker troubles, high air cooled side tuyeres that prevent clinker formations and increase grate area.

Instead of a "high strung" complicated power dump, a rugged dumping mechanism easily operated by one man.

These features merely brush the surface of Jones betterments clearly explained in the "A-C" catalog. Ask for a copy of the new edition.

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Alberta & Saskatchewan:
Mr. J. Twomey, Camrose, Alberta

British Columbia:
E. A. Earle, Limited
739 Hastings Street W.
Vancouver, B.C.

JONES "A-C" STOKERS

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Crane's Limited, Montreal.

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Canadian Johns-Manville Co. Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

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Dominion Flow Meter Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

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S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

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International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

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Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

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Canadian Johns-Manville Co. Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

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Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co.

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Canadian Johns-Manville Co. Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co. Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

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Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
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Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co. Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.

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Sanford Riley Stoker Co., Worcester, Mass.
Arthur S. Leitch Co., Ltd., Toronto.

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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
John Moncrieff, Perth, Scotland.
W. J. Wall, Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Arthur S. Leitch Co., Ltd., Toronto.

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MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

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Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que.
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Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

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Gelinas & Pennock, Reg'd, Montreal.
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Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

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Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Co., Toronto.

GRAVITY CARRIERS
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GREASE CUPS
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

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J. H. Williams & Co., Brooklyn, N.Y.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
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Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

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Yarnall-Waring Co., Philadelphia, Pa.

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Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

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Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
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Garlock Packing Co., Hamilton, Ont.
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MacGovern & Co., Inc., Montreal, Que.

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Beveridge Supply Co., Montreal.
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Canadian Johns-Manville Co. Ltd., Toronto.

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KEROSENE TANKS
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Lunkenheimer Co., Cincinnati, Ohio.

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Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

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Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Crane's Limited, Montreal.

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Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

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R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
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OILS, ENGINE
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OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
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Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS.
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Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

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Canadian Johns-Manville Co. Ltd., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Bolco Supply, Ltd., Toronto, Ont.

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MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgb, Pa.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane'a Limited, Montreal,

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ort.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE REGULATORS
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PULLEYS
D. K. McLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co. Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, BILGE.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford

PUMPS, CIRCULATION.
Smart Turner Co., Hamilton, Ont.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Smart, Turner Co., Hamilton, Ont.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
S'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton
The Fisher Governor Co (Inc.), Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Smart-Turner Machine Co.. Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co.. Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co.. Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co. Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Darling Bros Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.

RADIATORS
Crane'a Limited, Montreal.

RADIATOR TRAPS
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Bolco Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co, Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDEDS CO2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

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S. F. Bowser Company, Ltd., Toronto.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane'a Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

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Can. Link-Belt Co., Toronto, Ont.

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S. F. Bowser Company, Ltd., Toronto.

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Can. Link-Belt Co., Toronto, Ont.

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Beveridge Supply Co., Montreal.
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SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane'a Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
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Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
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STEAM CALORIMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

STEAM TRAP TOOLS
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B. F. Sturtevant Co., Boston, Mass.

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Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM SHOVEL
The Superheater Co., Ltd., Montreal.

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Canadian Johns-Manville Co. Ltd., Toronto.

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J. H. Williams & Co., Brooklyn, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Johns-Manville Co. Ltd., Toronto.

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal,
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

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Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TOBACCO PRESSES, HYDRAULIC
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MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston Mass.
Arthur S. Leitch Co., Ltd., Toronto.
J. T. Long, 81 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co, Julian, Boston, Mass.

TACHOSCOPES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

TACHOMETERS, INDICATING AND RECORDING
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co. St. Louis, Mo.

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Babcock & Wilcox, Ltd., Montreal.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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TUBES, COPPER AND BRASS
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
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Arthur S. Leitch Co., Ltd., Toronto.
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UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

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Dart Union Company, Ltd., Toronto, Ont

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Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd. Sarnia.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR
Lunkenheimer Co., Cincinnati, Ohio.
H. Mueller Mfg. Co., Ltd., Sarnia.
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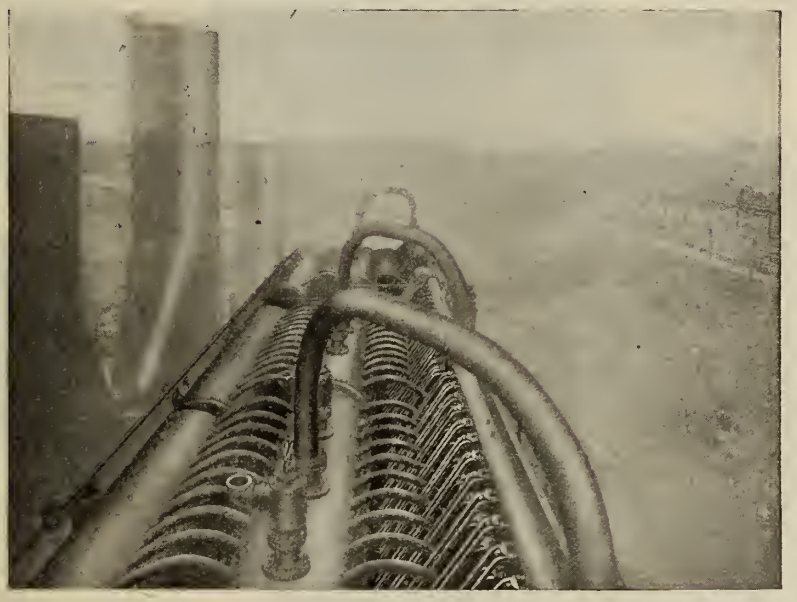

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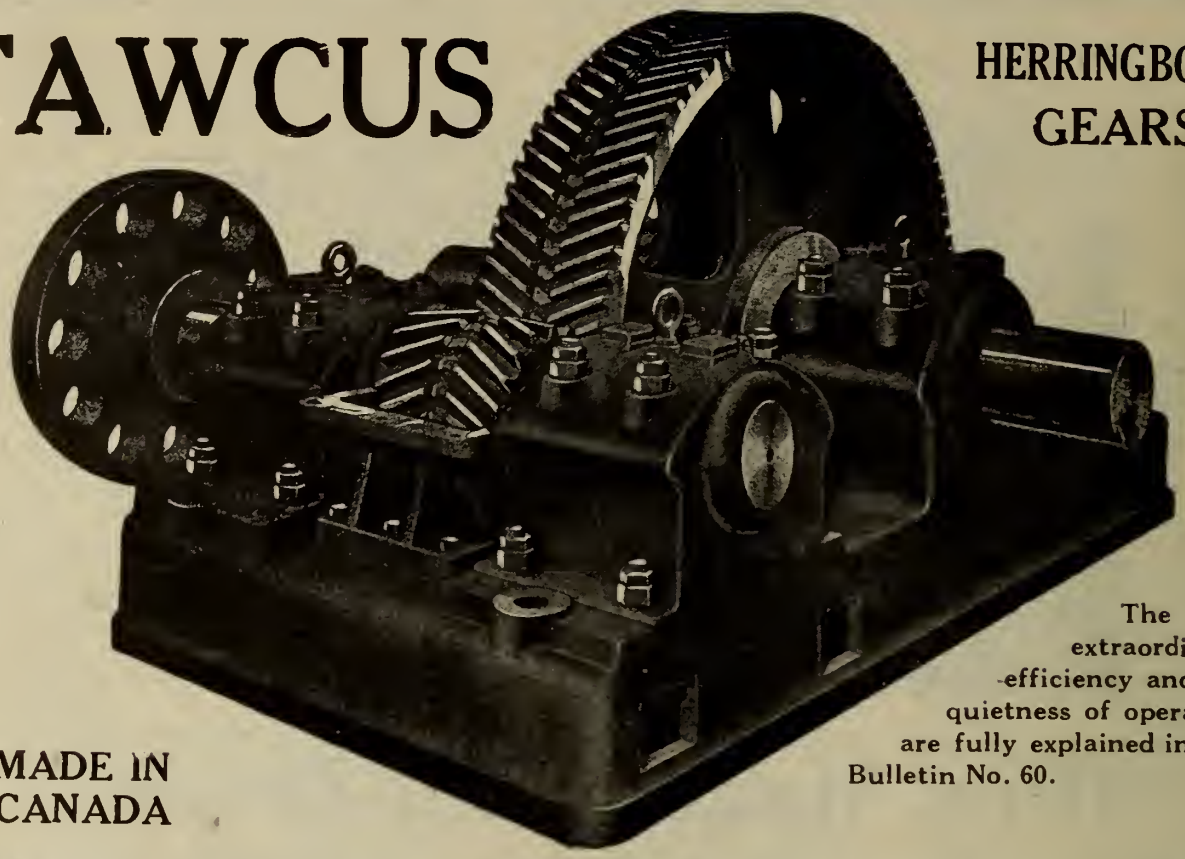

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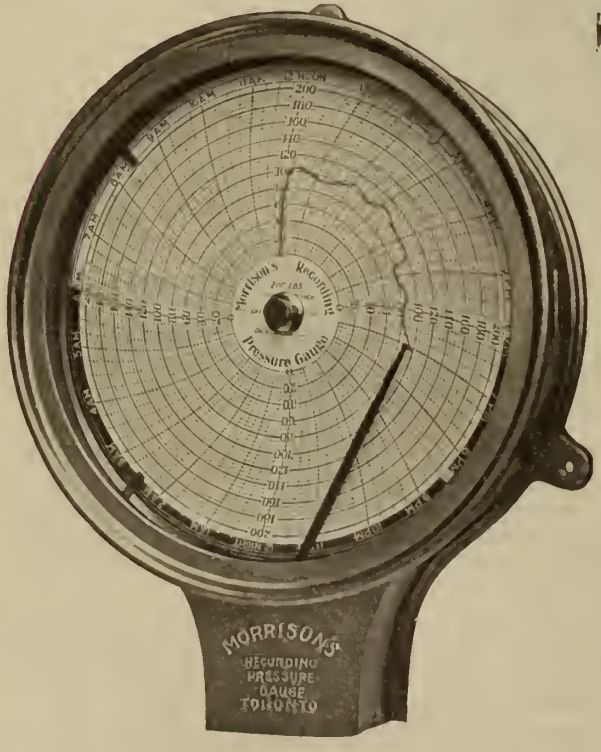

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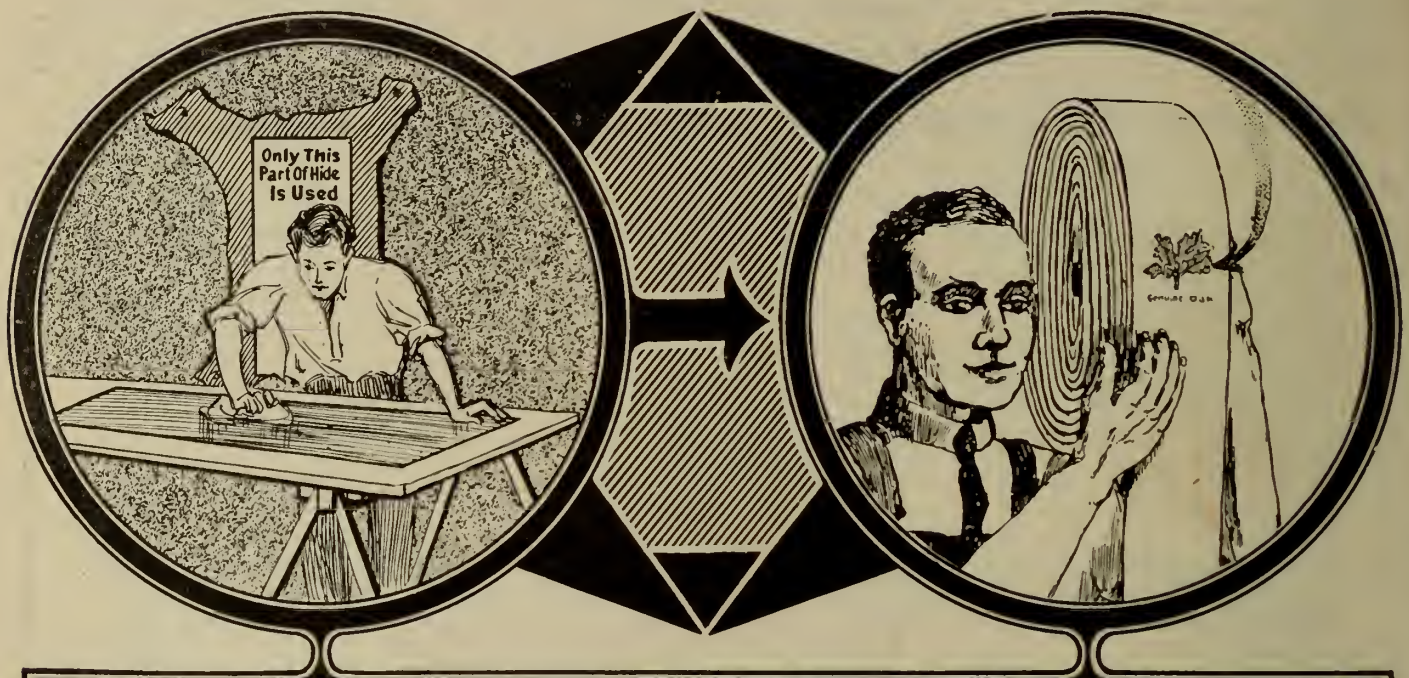

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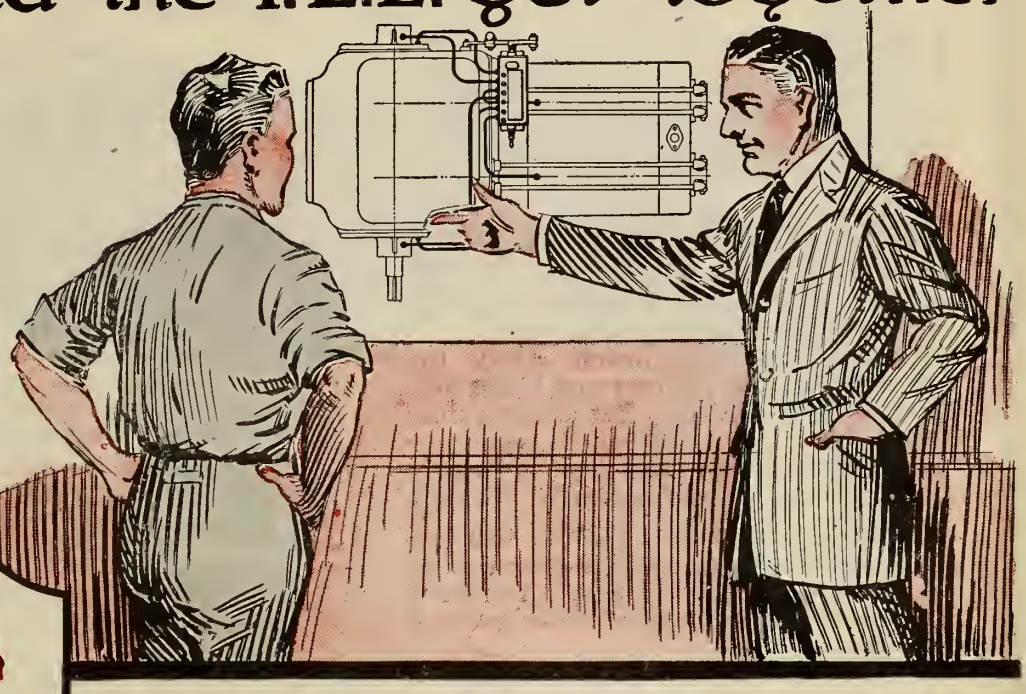

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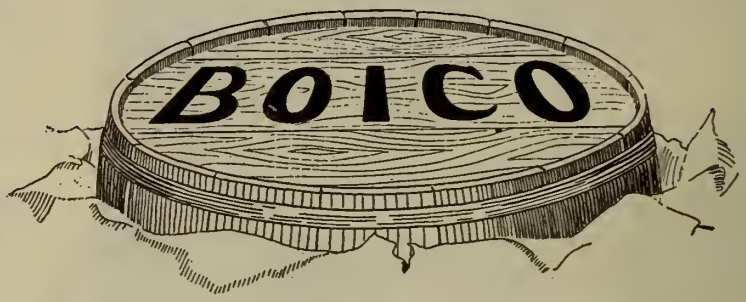

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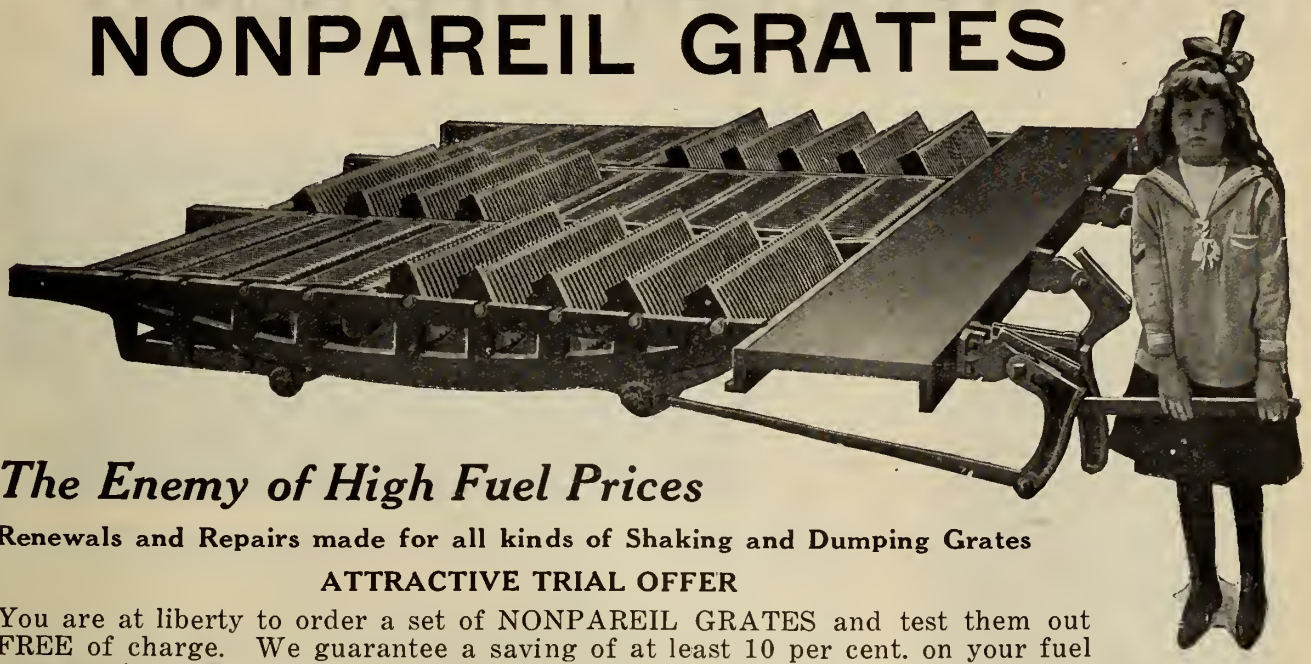

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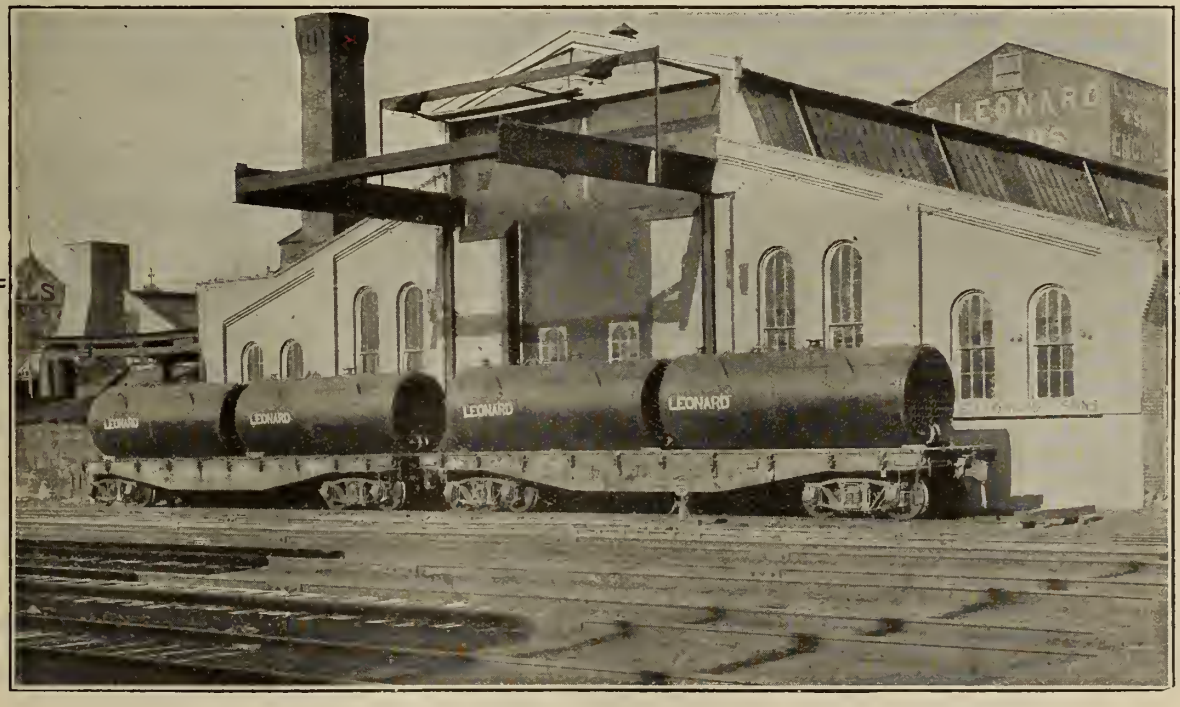

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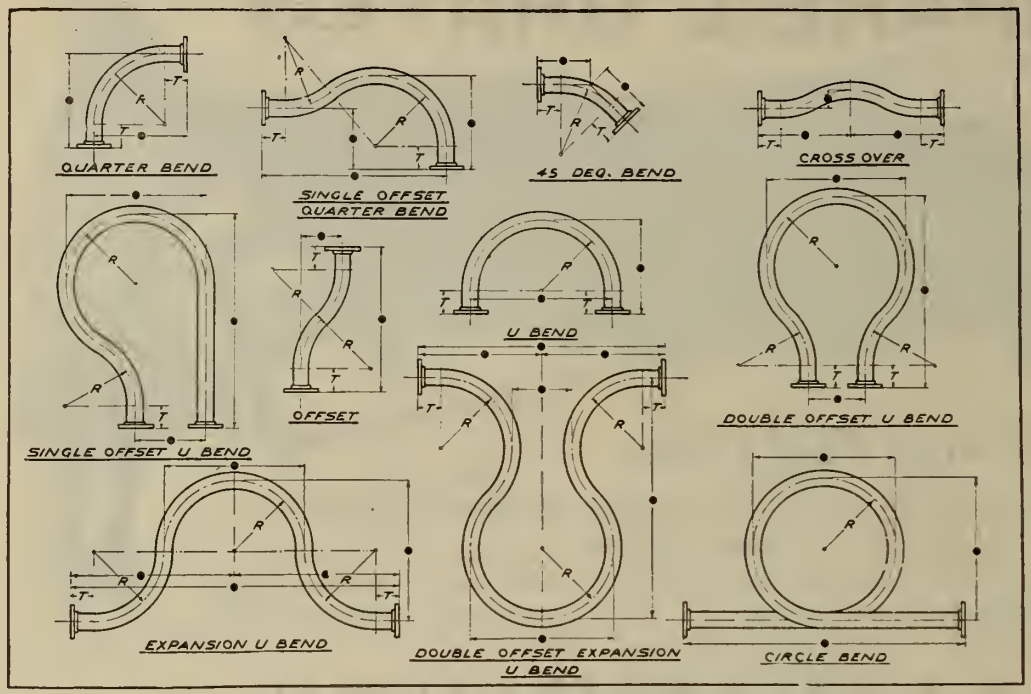

ALL KINDS AND SIZES UP TO 10" DIAMETER

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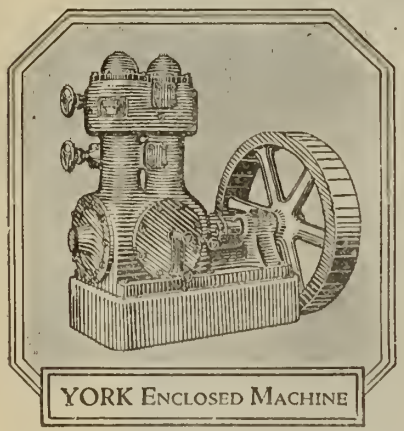

RELIABLE REFRIGERATION
For Every Practical Purpose

The governing factor in the selection of Refrigerating Equipment, in most cases, is the reliability of the machine. Can it be absolutely depended upon to perform the work? A shut-down during the warm season is always annoying and often is an item of expense, due to loss of production or deterioration of products in storage.

York Refrigerating Machines have demonstrated their absolute reliability by more than thirty-five years of satisfactory service, which has given them a high reputation throughout the refrigerating field.

Ice and Ice Cream Manufacturers, Meat and Produce Dealers, Creameries, Dairies, Confectioners, Grocers and many other industries are using York Mechanical Refrigeration profitably in the production and marketing of high grade products. If you require Refrigeration in your business, we should be pleased to have you investigate the York System.

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TORONTO: Villiers and Munition St., Eastern Harbor Terminals.
MONTREAL: .....324 Craig St. West
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YORK MANUFACTURING CO.

(Ice Making and Refrigerating Machinery Exclusively)

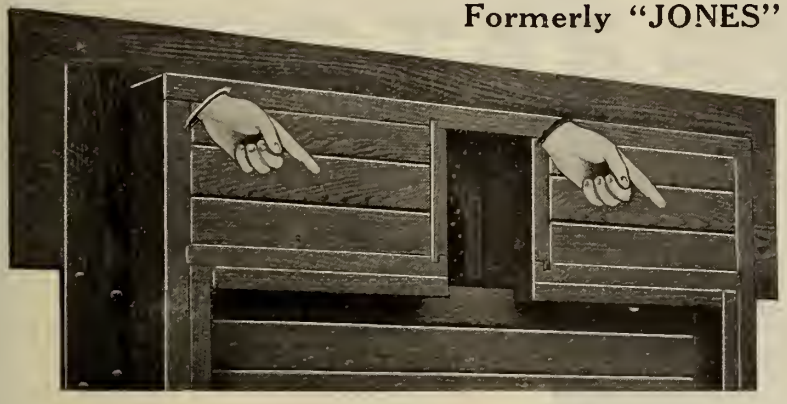
YORK, PA., U. S. A.

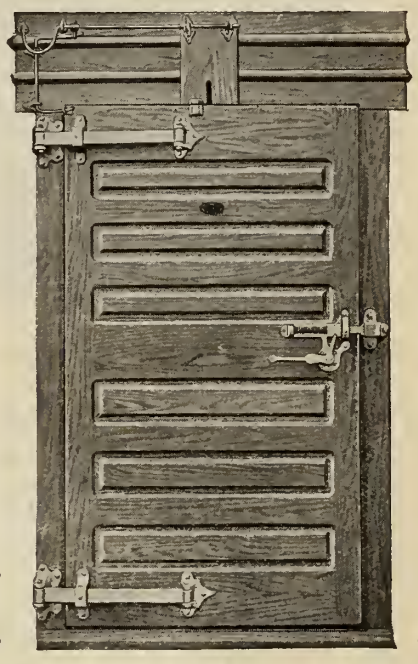
There is a YORK Plant to fit Your Business

Incomparable JAMISON

Formerly "JONES"

Heavy Duty Cold Storage Doors





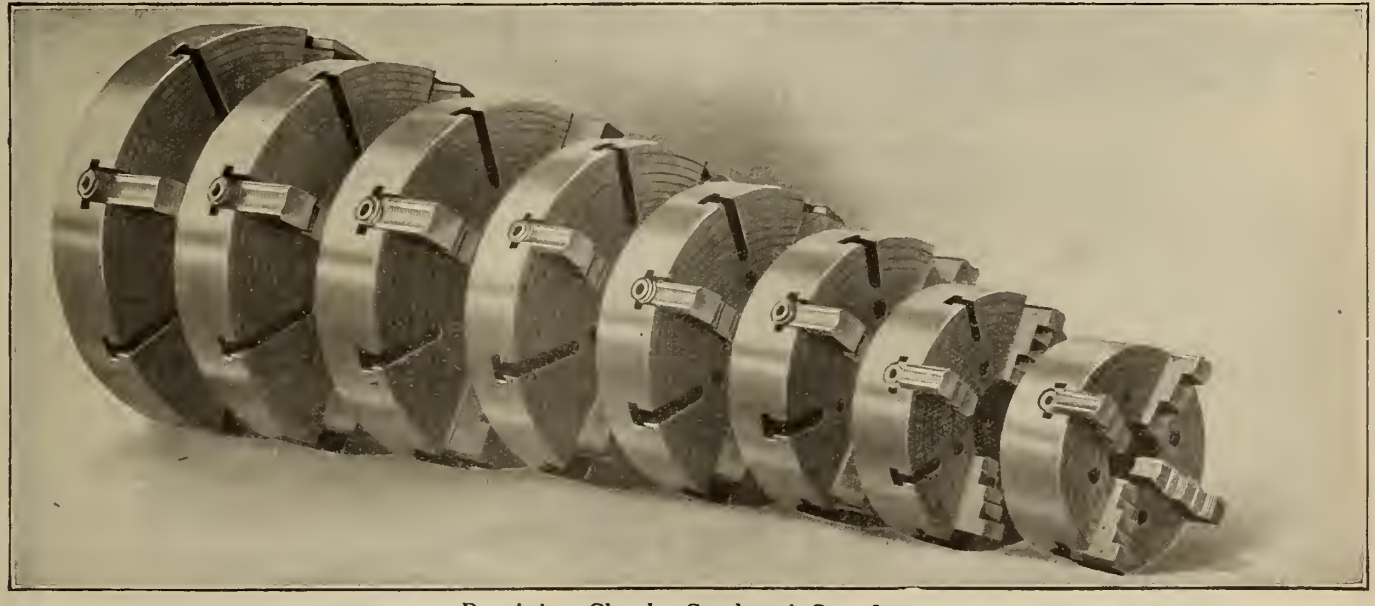
Have Many Points of Superior Construction

Note the back of our Standard Track Head Frame with track part; we insulate and finish our track frame heads, an unusual feature. Then note the simplicity of the Track Lift device over the door; no springs or other delicate parts to get out of order. Our Automatic Self-tightening Fastener draws the door rigidly tight each time it is slammed. The hinges too are three to five times heavier than other makes.
These features, and many others, are fully explained in catalog No. 10. Write for it.

JAMISON COLD STORAGE DOOR CO.

Formerly Jones Cold Store Door Co., HAGERSTOWN, MD., U.S.A.

DOMINION CHUCKS



Dominion Chucks, Steel and Cast Iron

Built for Long Life and to Stand Severe Service

Dominion Steel Products Co., Limited

Engineers and Manufacturers

Brantford - - - - Canada

CRANE
OIL SEPARATORS

Illustration shows Horizontal Type, which is made in all sizes.

Vertical Type, not illustrated, in sizes 1½ to 12 inch inclusive.

CRANE
OIL SEPARATORS

HAVE LARGE AREAS AND AMPLE BAFFLE SURFACES, AFFORDING THE HIGHEST DEGREE OF EFFICIENCY WITH THE SLIGHTEST LOSS IN PRESSURE.

Be sure that your oil separator is properly drained.

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

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CRANE-BENNETT Limited
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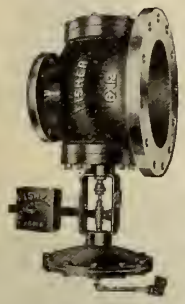
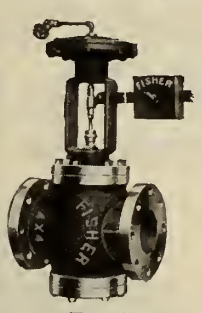

Type 11—A


Type 10

Simplicity and Reliability

You want your pressure regulators to be simple in construction and reliable in operation.

They must be accurate and so constructed that they will not stick—made of materials that will resist wire-drawing.

Fisher Pressure Regulators

have stood the test of time in service. Engineers have come to find that, once installed, and properly adjusted, they will render continuous, accurate service for unbelievably long periods of time.

TYPES 10 and 10-A are particularly adapted to low pressure service.

Types 11 and 11-A are especially designed for installations where expanded outlet valves are required, such as vacuum heating systems.

TYPE 55 is a spring controlled diaphragm regulator designed for use where the lever and weight type is not suitable.

These steam savers, like all Fisher Specialties, have been faithfully serving Canadian Engineers for many years.

"POWER PLANT SPECIALTIES" is a good book to have in your library. Write for your copy today.

The FISHER Governor Company

927 Fisher Avenue
Marshalltown
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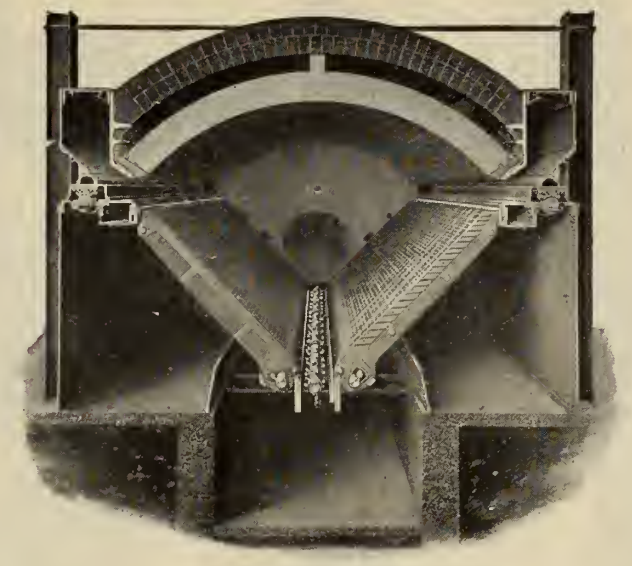
Agencies in all principal cities

Following is a partial list of Fisher Regulating Devices:

**Steam Pump Governors*
**Vacuum Pump Governors*
**Brine Pump Governors*
**Oil Pump Governors*
*Piston or Diaphragm types with either spring or lever and weight control.
Reducing Valves
Tank Controllers.
Back Pressure Valves
Exhaust Relief Valves
Steam Traps
Air Traps



Cutting Coal Costs

For 44 years Murphy Furnaces have been saving coal and lightening labor for thousands of users in every section of the country. Many reports are being received such as this from a City Hospital saying that they saved from seven to ten tons of coal per 24 hours over previous hand fired conditions.

MURPHY AUTOMATIC FURNACES

Here's why the Murphy Furnace is a fuel saver—it feeds the coal without opening the fire doors. The admission of cold air in large volumes is thus prevented; economy is secured and the life of the boilers is prolonged. The Murphy Furnace goes a step further. The fire is cleaned and the refuse removed automatically. This is a continuous operation and can be regulated to meet any condition. Every part of the fire chamber is visible and accessible. There is no periodic dumping nor drawing out of ashes, clinker, and incandescent fuel and coke, with resultant lowering of furnace temperature and steam pressure.

A request from you brings our Catalog HM-11 describing the Murphy Furnace in Full.

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

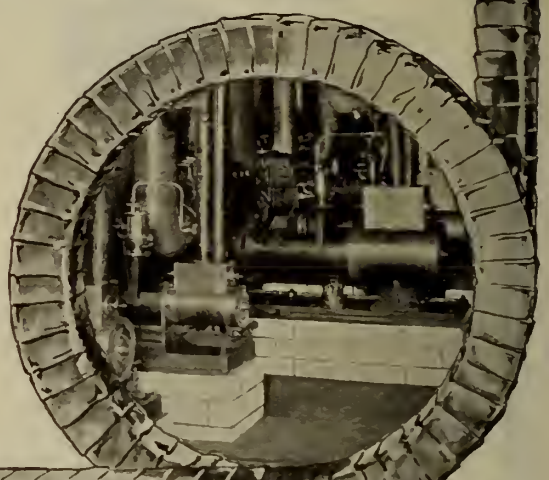
John Crane

Eight Years of Packing Service

JOHN CRANE Flexible Metallic Packing Shows Greatest Results in Constant Service

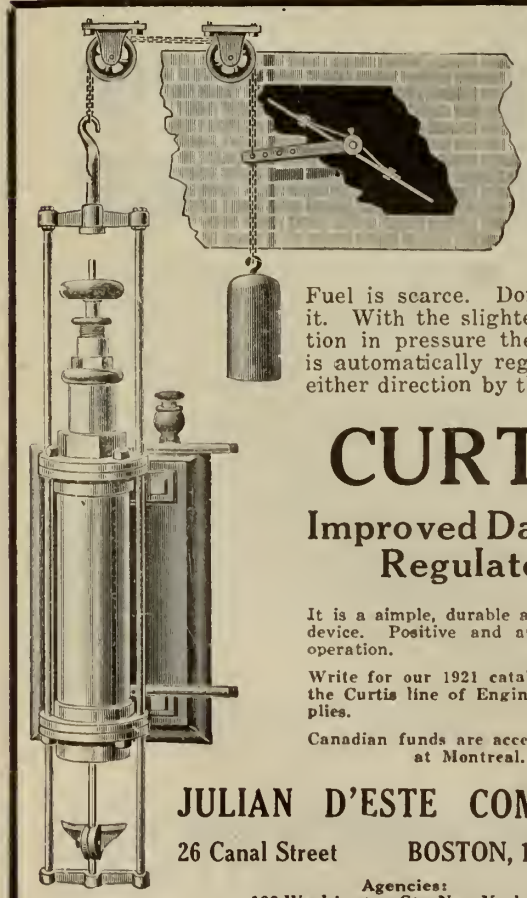
Eight years ago Chief Engineer, N. Gross, of the Standard Oil Building, Chicago, installed JOHN CRANE Flexible Metallic Packing in the boiler-feed pump pictured below. Mr. Gross reports packing and pump in good order after eight years and has standarized JOHN CRANE on all service.

JOHN CRANE holds this long service record because of its scientific, practical construction. Made of babbitt foil and graphite, it brings Packing science "The Babbitt-bearing Principle," and while responding to the slightest pressure of the gland never dries out, but remains compressible and will not score rods.



Write for your copy of "THE ANSWER" a book that tells unusually interesting things about packing problems.

The R. C. MILLER OIL & SUPPLY CO.,
38 & 40 YOUVILLE SQUARE, MONTREAL



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1921 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY
26 Canal Street BOSTON, 14, MASS.

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BUILD YOUR NEXT BOILER FURNACE LINING LIKE THIS

With Betson's Plastic Fire Brick it is easy for anyone, even without experience. No special forms or tools are necessary to lay up a one-piece, jointless furnace lining that is air and gas tight and free from the destructive effects of gases getting back of the fire brick lining, or expansion and contraction. No separate fire brick, tiles or blocks, and no clay mortar joints to give way.

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P. O. Box 386-6 — Rome, N. Y.

Canadian Distributor:
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LUNKENHEIMER
"Ferrenewo" Valves

"FERRENEWO" Valves are *economy* valves, proved so by their record of years in service. Low initial cost, wear resisting materials and the ease of renewal of all the parts should necessity require, makes them highly desirable for piping equipment where the pressure does not exceed 150 pounds.

LUNKENHEIMER "Valve-iron" from which "FERRENEWO" Valve bodies are made is an especially alloyed and processed Ferrous Composition. The renewable *seat ring* and *disc* are made of LUNKENHEIMER "Valve-nickel," while the bonnet, stem and bonnet ring are made of bronze compositions formulated especially for the duty each part performs.

The "FERRENEWO" material combination and unique design, coupled with the LUNKENHEIMER method of manufacture insures successful results under the wide range of operating conditions for which "FERRENEWO" Valves are adapted.

LUNKENHEIMER Distributors situated in every commercial center carry "FERRENEWO" Valves in stock for immediate delivery.

To standardize on "FERRENEWO" Valves is to *economize* in valve cost and maintenance.

THE LUNKENHEIMER CO.
"QUALITY"

LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD

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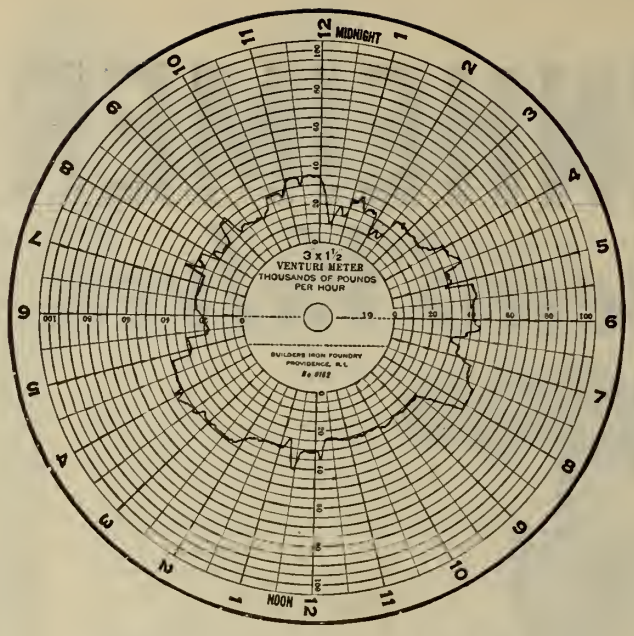
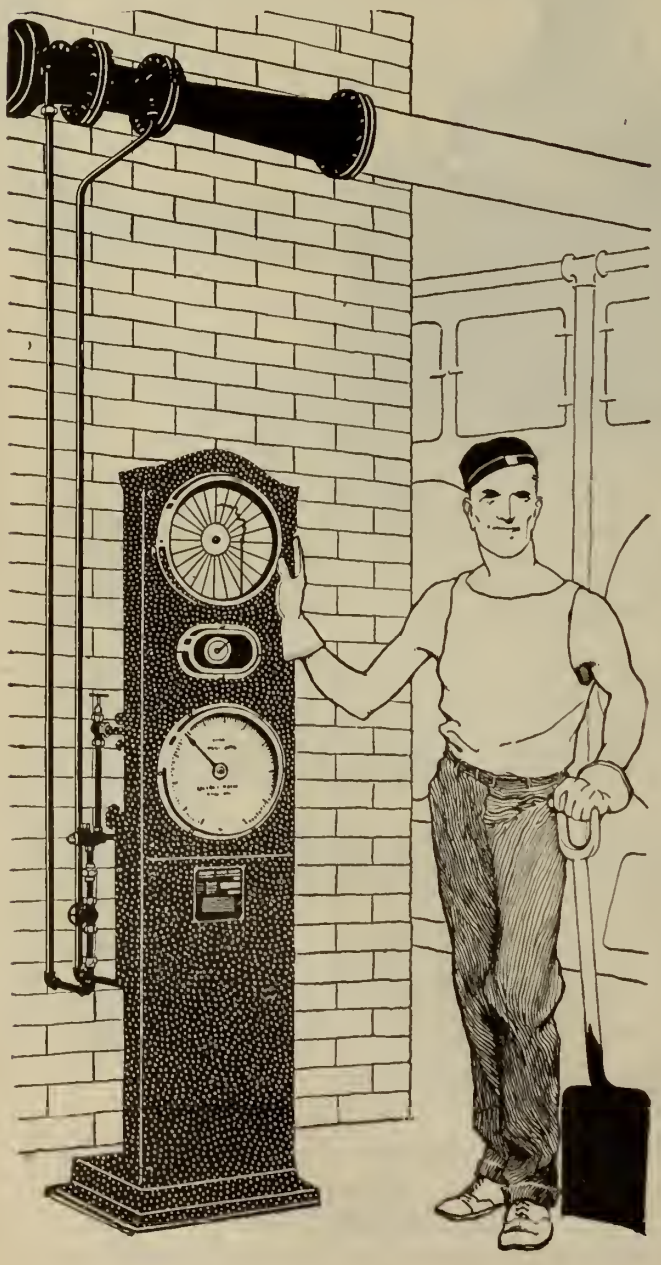


This chart shows economical boiler feeding



FIRM FRIENDS

The Efficient Fireman and the Venturi Meter!

It is only the lazy and careless boiler tender who has no welcome for the Venturi, since it clearly reveals daily his wasteful methods.

The man who is alive to his employer's interest and who realizes that every possible B.t.u. must be squeezed out of the costly coal pile points with pride to the improvement he has made "since the Venturi was installed."

Bulletin No.197, "Why Your Power Plant Needs a Venturi," is Ready.

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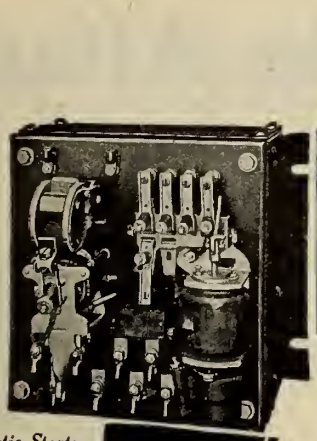
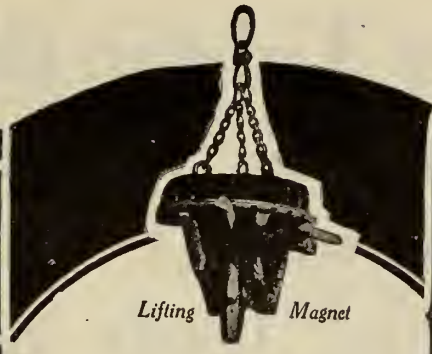


Automatic Starter



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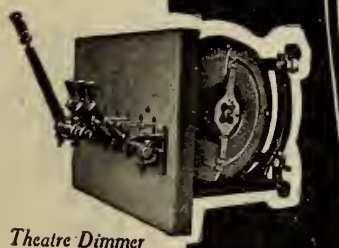
Compensator

Magnet and Control Devices

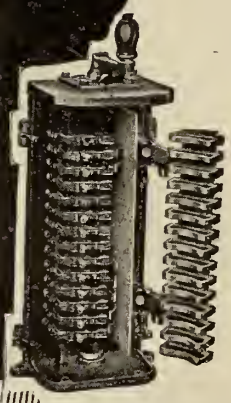
¶ Cutler-Hammer Lifting Magnets and Magnetic Separators have proved of exceptional value in the mining field, in steel mills and in many other industries for lifting and separating metals. The Magnetic Clutch and electrically operated Brake, used primarily in steel and rubber mills and for crane control repectively, are widely applicable to many industries where the gradual engagement or adequate braking of a load is desirable.

¶ In electric controlling devices of all kinds Cutler-Hammer is the recognized standard of dependability, whether for fine speed adjustment of a machine, extremely close voltage regulation, the wonderful light dimming and colour effects in a modern theatre, or the automatic control of heavy loads or other special operations.

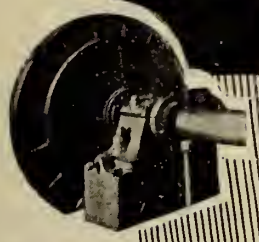
¶ Details and recommendations of suitable Cutler-Hammer apparatus for your control problems are available at our branches.



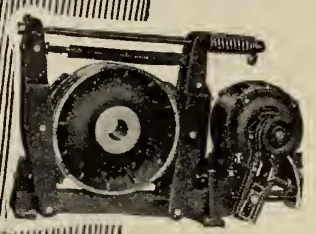
Theatre Dimmer



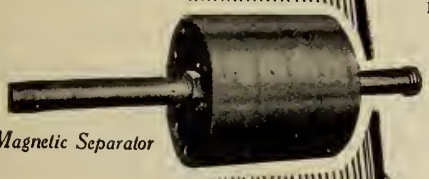
Drum Controller



Magnetic Clutch



Motor Operated Brake



Magnetic Separator

Northern Electric Company LIMITED

Montreal Quebec Toronto London Regina Edmonton
Halifax Ottawa Hamilton Windsor Winnipeg Calgary Vancouver

"There is a Tide in the Affairs of Men which Taken at the Flood leads on to Fortune"

—Shakespeare

ncorporated, May 1887

The better education of its members in the science of steam engineering.

—To protect the competent engineer and his vocation.

—To enroll all competent engineers in this organization.

—To impart information beneficial to the profession.

Incorporated at Ottawa June, 1917

—To assist members out of employment to obtain the same.

—To procure by legal enactment greater safety in the operation of steam plants.

—The belief that knowledge and ability of one's profession is what is necessary to make success possible.

Now is the time—not to-morrow—when you will get the most benefits from membership in the

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS

IN THESE testing times the man who makes his mark is the man who devotes a large part of his leisure hours to further improvement in his chosen profession.. The important part that class organizations are doing to forward this expansion can be seen when a survey is made of the large number of associations that have sprung to life in the past few years. The underlying motive of all these associations—greater individual development—is very outstanding in the case of the CANADIAN ASSOCIATION of STATIONARY ENGINEERS. This organization by means of illustrated and non-illustrated lectures, provides its members with all up to the minute progress made in the engineering profession.

A GLANCE at the upper panels will show the important principles of this important organization. They are worthy of serious thought.

Any man interested in an association of this kind and living where less than fifteen engineers reside may send for a copy of our constitution and make application to the nearest lodge for membership. If living where there are more than fifteen engineers it is advisable to get together and send in a written application. The undersigned will be very pleased to give any further information required.

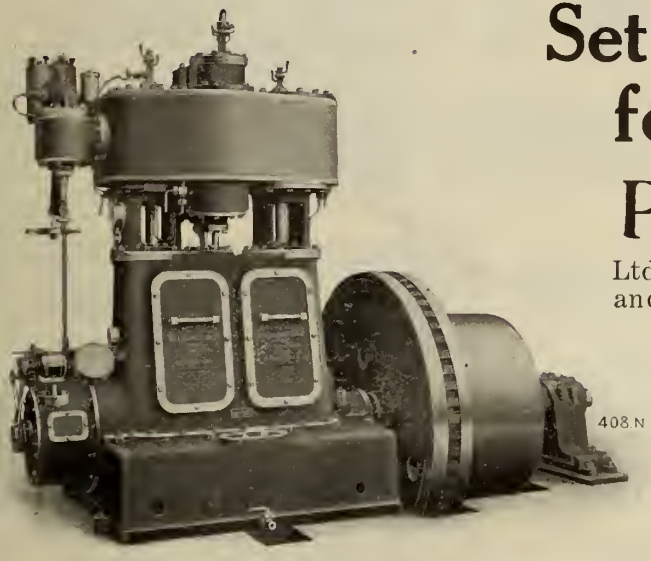
F. HARPER

President Grand Lodge, 89 Bay St., Kingston

L. J. ELLIS

Sec.-Treasurer Grand Lodge, 142 East Avenue N., Hamilton

Belliss & Morcom



Belliss & Morcom Compound Engine with Belt Pulley Drive

Sets the Standard for Efficiency

PERHAPS no other power plant equipment has won so much world wide approval as the famous products of Belliss & Morcom, Ltd. Belliss & Morcom Steam Engines, Steam and Exhaust Turbines, Air Compressors, Crude Oil Engines and Condensers are stamped by the greatest engineering authorities as the "closest to absolute perfection." Their use of course means longer and better service with corresponding decreased costs.

In addition to Belliss & Morcom Equipment we handle those displayed at the left. Complete Power Plants designed, erected and equipped. Write for information.

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Water Softening Plants
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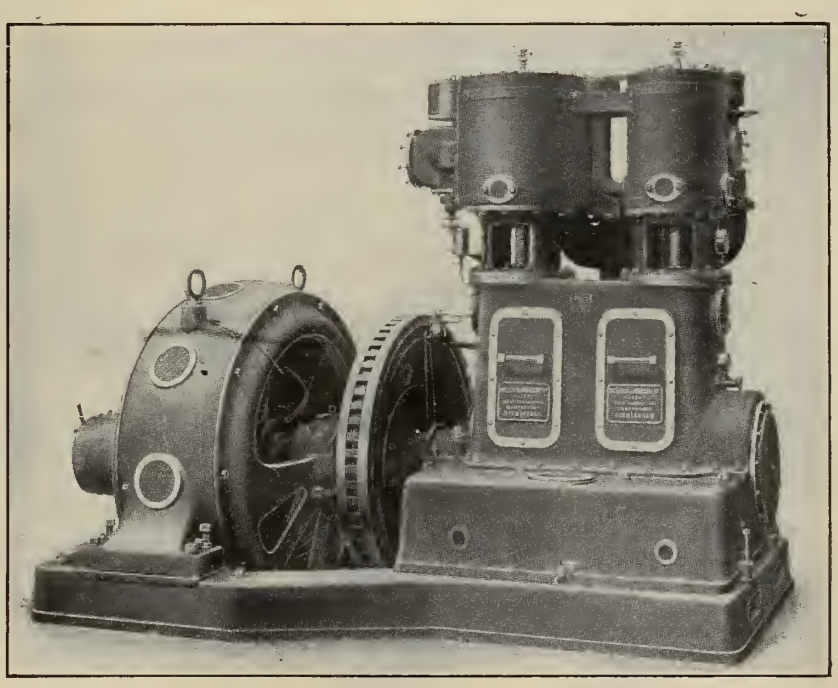

Belliss & Morcom Motor Driven Air Compressor

BELLISS & MORCOM, LTD., Birmingham, England

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CATCH THE CINDERS

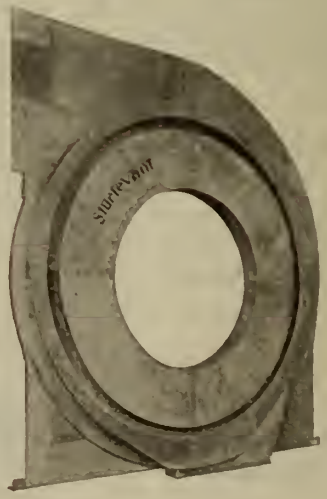
Cinder-Eliminating Induced-Draft Fan

A FAN FOR A DOUBLE SERVICE

1. To eliminate the cinder nuisance.
2. To furnish induced draft efficiently.

Designed to secure both these results in a single unit requiring no more space or attention than a standard fan.

Proved by uniformly successful installations in important plants in large cities throughout the country.



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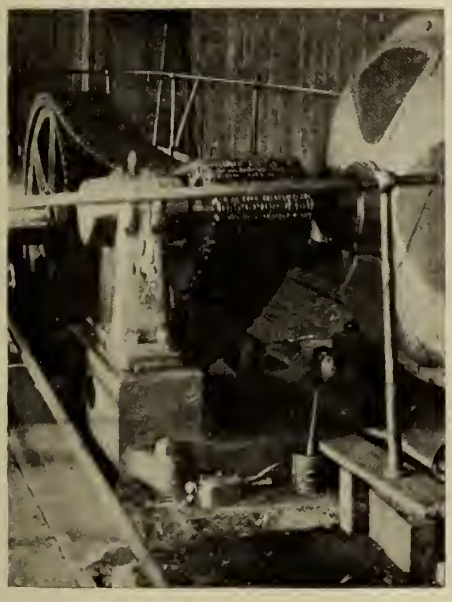
DRIVING CHAINS



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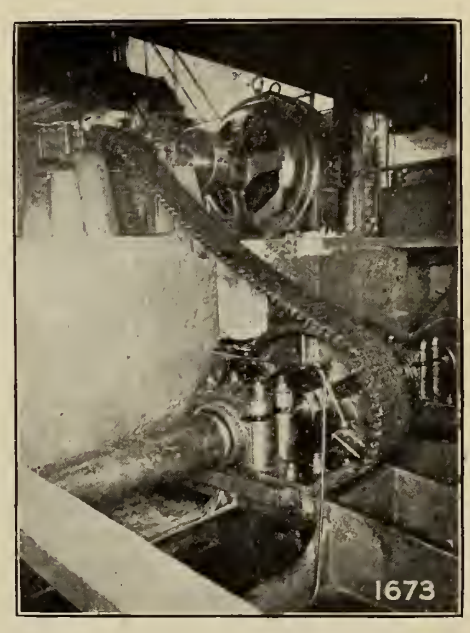
THE SYMBOL OF QUALITY

The Chain With a World-wide Reputation



125 H.P. Line-Shaft Drive in Paper Mill

Save Power -- and Ensure Greater Production!

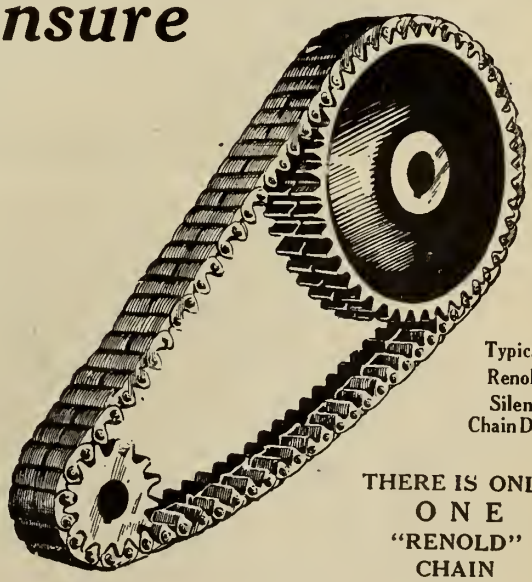
RENOLD DRIVING CHAINS—

(1) Have a maintained efficiency of 98.2%.
(2) Save power.
(3) Ensure maximum production.
(4) Run SLACK between shaft centres, thereby eliminating bearing friction and reducing maintenance costs.
(5) Are not affected by heat, cold or moisture.
(6) Require little or no attention when once installed, etc.

Our ENGINEERING SERVICE is entirely at your disposal.

Write for Bulletin, "Notes on the Selection of Chain Gear."

We carry large stocks of Silent and Roller Chains at Montreal. Quickest possible deliveries of complete Drives ensured.



Typical Renold Silent Chain Drive

THERE IS ONLY ONE "RENOLD" CHAIN

Sole Canadian Representatives:

HANS RENOLD OF CANADA LIMITED

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Jones "A-C"

Jones "A-C" Stokers

are automatically cleaned, high-duty stokers. From coal-hopper to ash discharge the cleaning is entirely automatic. No hand labor is needed. No trouble is experienced from big clinkers in the fire—and no clinkers are formed either on the bridge wall or side walls.

As the steam-driven rams push the charges of green coal into the retorts, the entire fuel bed is slowly pushed toward a balanced dump plate at the rear. This is ***not*** a gravity movement. The incline of the retorts is not sufficient to to cause avalanching. By the time the fuel bed reaches the rear of the furnace, the fire is burned out and nothing is deposited on the dump plate but dead ash and refuse. This dump plate is so balanced that it is easily and quickly operated by hand. No power driven dumping mechanism to cause trouble.

The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Co., Ltd., has recently been reorganized as the Under-Feed Stoker Co., of Canada, Ltd., and the reorganization makes available for Canadian Power users the extensive engineering resources of the Under-Feed Stoker Co. of America.

Jones "STANDARD"

Jones "Standard" Stokers

are very simple. There are no moving parts in the fire—and very few moving parts of any kind. Simplicity and easy accessibility insure low maintenance costs.

Fuel and air supplies for both types of Jones Stokers are controlled automatically, and proportioned for complete combustion and high efficiency with any grade of coal. Smoke is waste—with Jones Stokers there is no waste. The automatic controls can be adjusted to maintain any desired steam pressure within very close limits—regardless of sudden changes in load.

Jones "Standard" Stokers can be installed under limited space conditions. No ash pits or other excavations are necessary. Old boilers can be equipped without changing settings. Wherever installed, they increase fuel efficiency and reduce operating and maintenance costs.

The Under-Feed Stoker Co. of Canada, Limited
81 Victoria Street, Toronto

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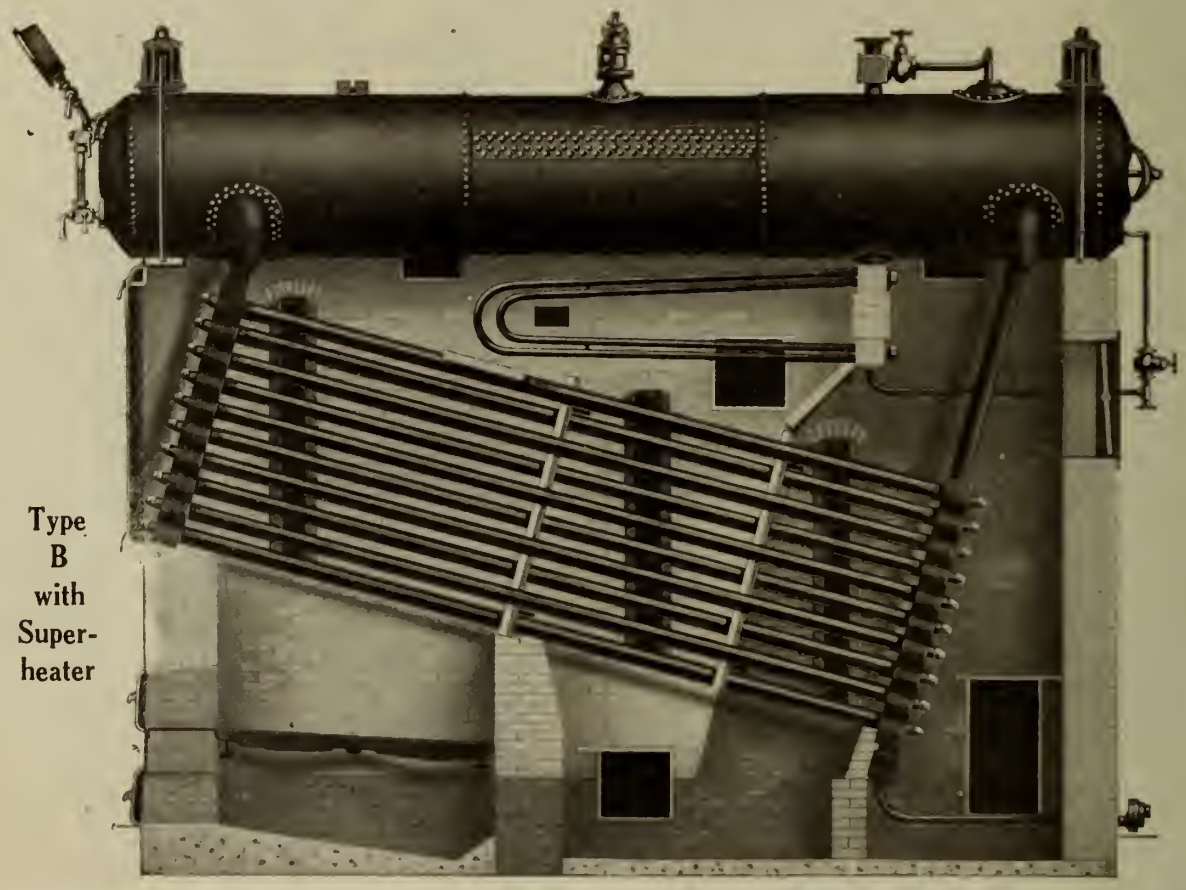

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Using Bleeder Steam in Factory Heating

Bleeder Extraction—Elementary Turbine Theory—The Bleeder —Automatic Control of Bleeder Valve — Necessity of Check Valve—Dash Pot on Check Valve—Volume of Steam Extracted —When It Pays to Bleed Steam

By J. A. McGILLIVRAY

OF LATE considerable space has been given to the discussion of the value of exhaust steam for heating purposes. In the October 20th issue of Power House the question was discussed by Mr. Fenner, who demonstrated the benefits of increasing the back pressure on the engine as compared to using a reducing valve to bleed high pressure steam, basing his argument on a heat unit basis, which is the only correct way to approach the subject. I think the readers of Power House will grant that he clearly drove home his argument with respect to this statement, that the heat units (B.T.U.) required by the engine for a given amount of work were the same, regardless of what the back pressure was, and that provided the steam exhausted (all the steam) could be utilized for heating, it was not a loss to increase the engine back pressure for purpose.

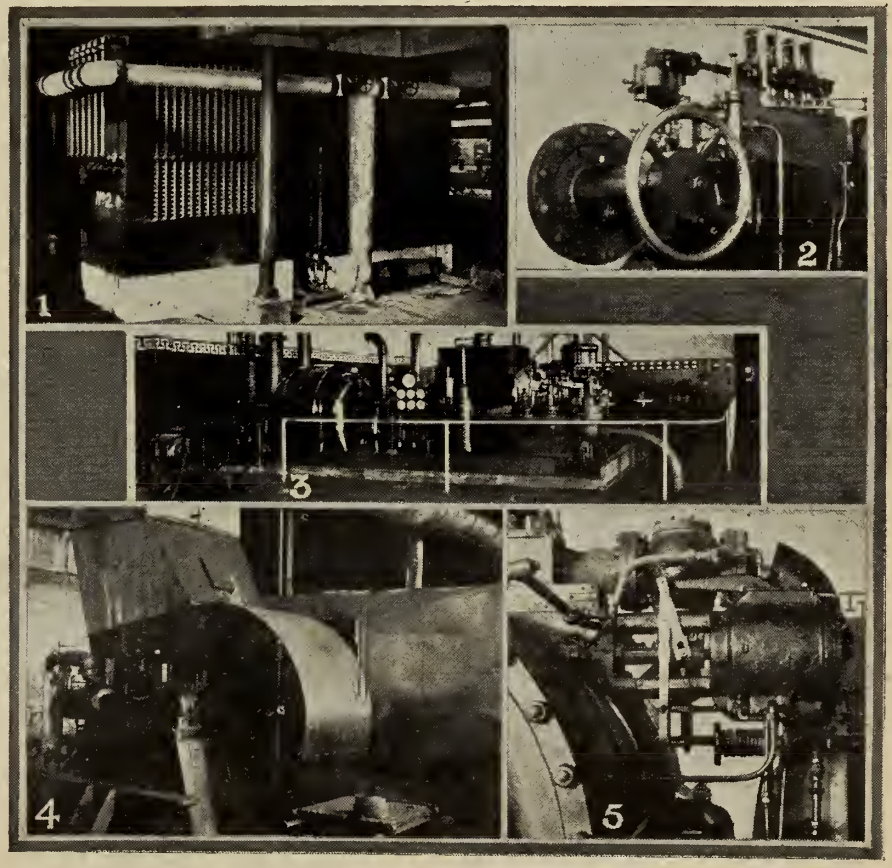
Hitherto the discussion has been mainly confined to utilization of the exhaust from reciprocating steam engines, and rightly so, since non-condensing steam engines are to be found in the majority of plants, where heating is a consideration and have well deserved recognition by right of early establishment in the industrial field. Their simplicity of operation and dependability for many classes of work, makes the reciprocating steam engine as a prime mover, more popular than the turbine, especially in moderate sizes. Nevertheless, the steam turbine is coming to the front, and has a field all its own where it greatly excels the reciprocating engine, and one of the most interesting types is that known as "Bleeder Type."

Bleeder Extraction

The Bleeder Type is especially furnished where low pressure steam is required for heating purposes, such as process work, or factory heating, in combination with Electric motive power. Bleeder Types are designed for a variety of conditions of operation, both in condensing and non-condensing units, or any combination of the two.

Fig. 1. shows a Westinghouse Parsons bleeder type designed to operate non-condensing in a sugar refining plant, where two different pressures were required for process work as well as electric generation. The turbine exhausts into the low pressure line at 8 lbs. gauge (23 lbs. abs.) and at the same time bleeder steam is extracted from the 1st stage at 45 lbs. gauge (60 lb. abs.) using steam at the throttle at 160 lbs. gauge. The volume of steam that can be extracted from a steam turbine is, of course, a function of the load. (This feature will be described later in this article).

The method of steam extraction from between the stages of a turbine depends on the class of service the steam is used for, and whether the generator load is steady or variable. If the generator load is fairly constant and the amount of steam required is constant (within the capacity of the turbine) the extraction is obtained by manually adjusting the extraction valve to deliver the predetermined amount of steam, but if the generator load is variable this will be unsatisfactory since an increasing load will cause the governor to admit more steam to the first stage, the bleeder ports being adjusted to let a constant volume flow to the second stage. The increased volume admitted to the first stage must



1.— Vento Cast Iron Heaters. 2.— Valve Gear and Mixed Pressure Turbine. 3.— Westinghouse Non-condensing Bleeder Turbine. 4.— 84 inch Sirocco Fan. 5.— Curtis Automatic Extractor Gear.

pass to the bleeder line. The first stage wheel takes the swing of the load, the bleeder line pressure varying accordingly. To overcome this disadvantage an automatic extraction device is used, a modification of which is shown in Fig. II.

In order to understand the effect of extracting steam from between the stages of a turbine we should know something about the elementary theory of steam turbines.

Turbine Theory

The statement is sometimes set forth that all the kinetic energy of the steam is absorbed by the wheel of the first stage, and the steam then extracted for heating, retaining all its heat. This is an exaggeration, pure and simple, since if the wheel does any work at all it is at the expense of heat.

Let W= Wt. of steam in lbs. per sec.

Let E =energy given up by one lb of steam in ft. lbs.

Let P_1=initial pressure lbs. per sq. in. (abs.)

Let Pn=final pressure lbs. per sq. in. (abs.)

Let H_1=heat content per lb. at the initial pressure.

Let Hn=final heat content per lb. (at last stage pressure).

The heat available for doing useful work is W (H1 - Hn)=B.T.U. available

If the steam expands against a resistance, as for example, an engine piston, the energy given up in forcing the piston forward may be expressed E_1=778 w (H1-Hn)=Ft. lbs.

If the steam expands within a perfect nozzle the energy will be given up in imparting velocity to the steam itself.

Thus $E=W\left(\frac{V^2}{2g}\right)$=ft. lbs. in which

V= velocity in ft. per second.

If the velocity (V) is retarded to (v) ft. per second

$$E=\frac{W(V^2-v^2)}{2g}=\text{ft. lbs. per second.}$$

If all the energy was absorbed by the wheel ignoring all losses, the final velocity (v) would be O, since the energy E is completely absorbed, it follows that the velocity becomes zero.

$$\text{Then } E=\frac{W(V^2-v^2)}{2g}=\frac{W(V^2-O)}{2g}=\frac{WV^2}{2g}$$

Now then

$$E=\frac{WV^2}{2g.}=778W\ (H_1-Hn)$$

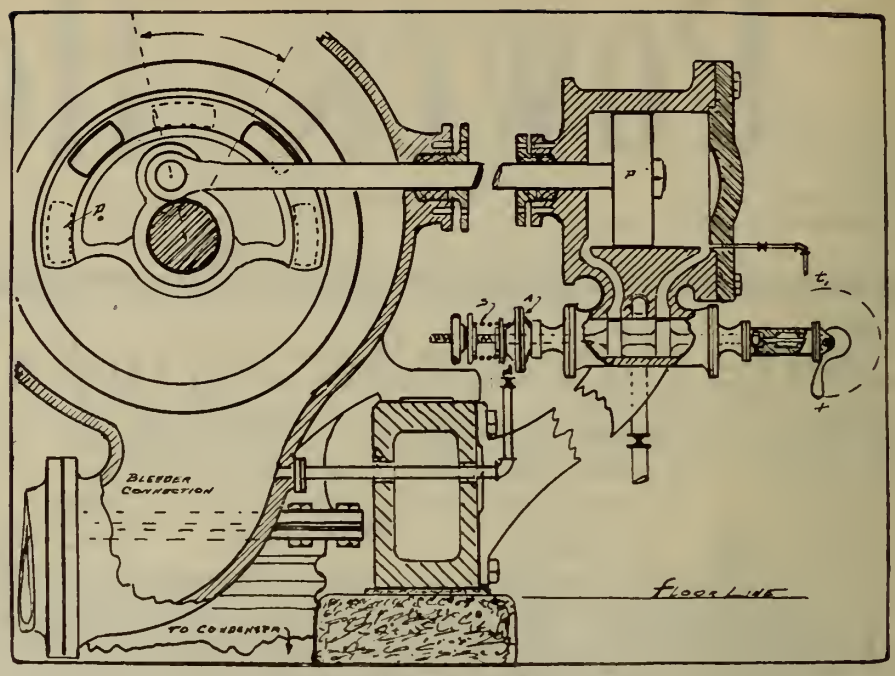
Combining and transposing

$$V^2=(HI-Hn)\ 778 \times 2g.$$

And $V=\sqrt{(H_1-Hn)\ 778x2x32.16}=V\ 224\sqrt{(H_1-Hn)}$. If there are (N) pressure stages.

$$V=224\sqrt{\frac{(H_1-Hn).}{N}}$$

From the foregoing it can be seen that the energy varies as the square of the velocity, and directly with the heat drop,



Showing Automatic Extraction Gear.

or, if the wt. = 1 lb., E=(H-Hn) 778,

also $E=\frac{V^2}{2g.}=\frac{V^2-v^2}{2g.}$

This is where the error is made by those who state that all the energy of the steam is given up to the first stage wheel.

Let us take an example as follows: Assume a two stage turbine where the entrance velocity to 1st stage is (V) and the exit velocity from that stage is (v)=O. That is, the steam has no velocity leaving the 1st stage wheel until expanded in the 2nd stage nozzles, and the total heat drop between the 1st stage nozzles and the condenser is (H-Hn.)

The heat drop per stage is $\frac{(H-Hn)}{2}$ and the velocity V represents only ½ the energy of the steam, instead of the total amount, yet the equation is correct as it stands.

$$E=W\left(\frac{V^2-v^2}{2g}\right)=W\left(\frac{V^2-O}{2g}\right)=\frac{WV^2.}{2g}$$

But also equals (H-Hn) 778.

Consequently if the turbine was a four stage machine the energy per stage would be 778 $\left(\frac{H_1-Hn}{4}\right)$ and assuming that steam was bled from between the 3rd and 4th stages, it would be quite correct to assume that ¾ of the available energy for doing work in the turbine was absorbed by the three preceding wheels (assuming, of course, ideal conditions; the actual performance of steam turbines is about 80% of the ideal), while the heat content corresponding to the bleeder pressure is available for heating, plus whatever superheating may be present in the bleeder stage.

The Bleeder

Let us consider a case in point. Where steam is to be bled from between the stages of a two stage condensing steam turbine, using steam at the initial pressure of 175 lbs, gauge, and a condenser pressure of 1 lb. absolute. The bleeder pressure is to be 5 lbs. gauge.

According to the elementary theory of the turbine the pressure between the stages will be that corresponding to the heat drop, or $\frac{H_1-Hn}{2}$ for a two stage machine. The total heat drop from the initial to the condenser is

(H' - Hn)=1198.5=1104.4=94 B.T.U.

and the heat drop per stage $=\frac{94.1}{2}$

= 47.05 B.T.U.

The corresponding pressure for the heat drop of 47.1 B.T.U., or (1198.5—47.05) = 1151.45, and the 1st stage pressure is 1 lb gauge. Since we are to bleed steam at 5 lbs. it is clear that something must be done to increase the 1st stage pressure to 5 lbs. and the simplest way to accomplish this is to choke off the steam on its way to the 2nd stage, hence the extraction device shown in Fig. 3.

The stage pressure will vary with the turbine load and is less than atmospheric pressure at partial loads, and in actual condensing turbines does not usually exceed atmospheric pressure in the 1st stage even at full load. Since the stage pressure is constantly varying with the swing of the load it is evident that any certain setting of the bleeder valve will be unsatisfactory the moment the load changes. If, for instance, the ports leading to the second stage are half closed in order to maintain 5 lbs. pressure in the 1st stage, when the turbine load is 50%, an increase in the load must be carried by the 1st stage wheel, so long as the admission to the second stage is constant, the result will be an increase of pressure in the 1st stage, due to increased volume of steam admitted, a con-

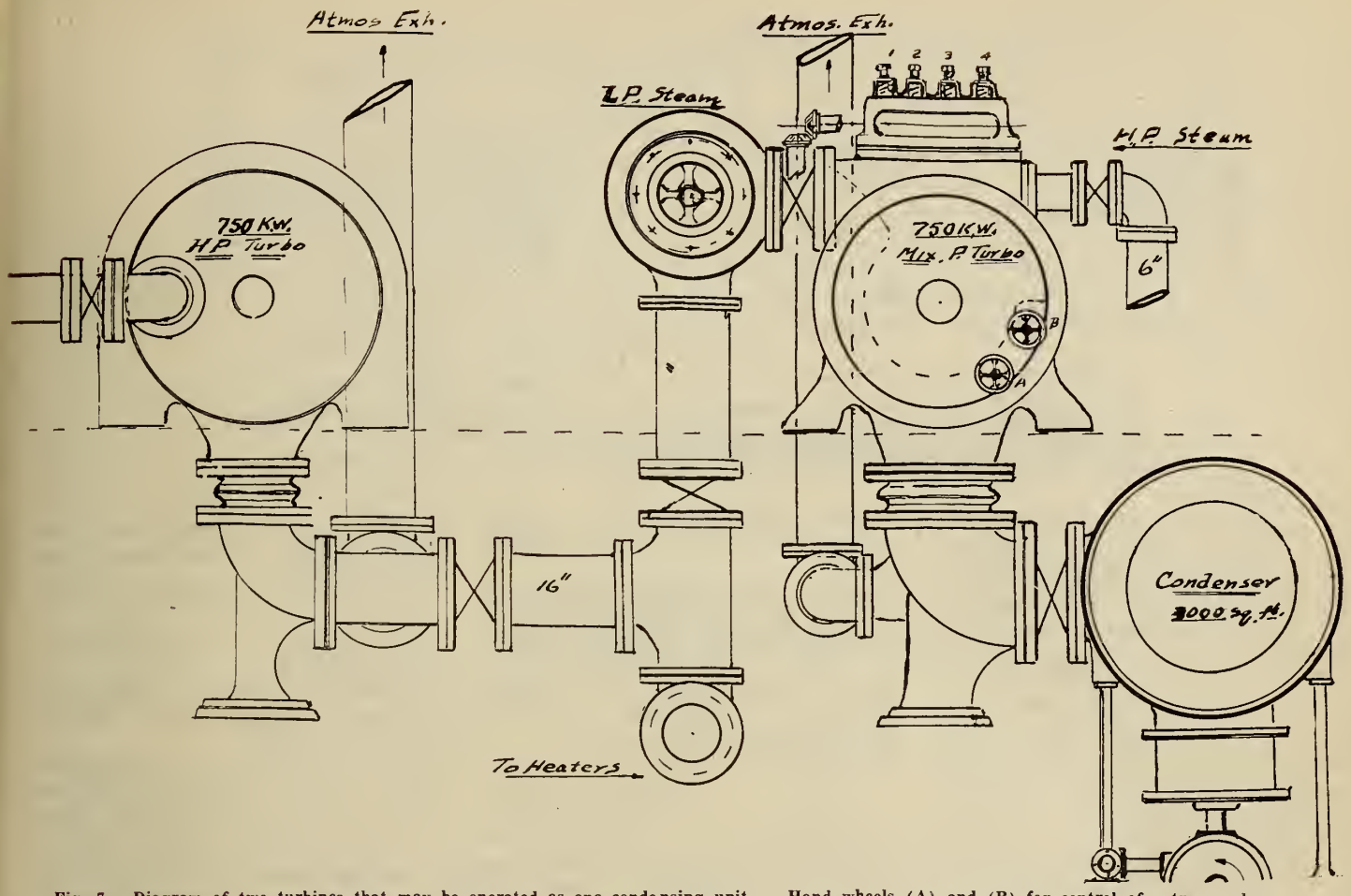


Fig. 7 — Diagram of two turbines that may be operated as one condensing unit. Hand wheels (A) and (B) for control of extra nozzles increasing or decreasing the h.p. steam as conditions warrant. For actual layout of piping see Fig. 6.

sequent corresponding lowering of the efficiency of the 1st stage wheel and an increase of pressure in the bleeder line, while a diminution of the load produces opposite effects. It is now evident that the extraction valve must be automatic in order to maintain constant stage pressure, with varying loads. That is, the opening to the last stage nozzles must be automatically adjusted. Where the load is fairly constant, the extraction valve may be manually adjusted.

Automatic Control of Bleeder Valve

Referring to Fig. 2, which is an exaggeration of the automatic extraction device. The position of the piston valve which covers the ports of the extraction cylinder is determined by the pressure, in the bleeder stage, as follows: When the pressure builds up, it acts on diaphragm (A), causing the valve to move to the left, admitting steam to the left side of the main piston (P) which travels to the right, opening the ports to the second stage. When the pressure falls off in the bleeder line the operation is reversed. The bleeder pressure is determined by the tension on spring (S) which oppose the diaphragm. When the bleeder pressure times the diaphragm area equals the spring tension, the valve remains stationary.

When the extraction device is not in use the cam (t) is turned into position tl, which forces the valve to the left, causing the piston to travel to the right, where it remains, the ports (P) being thus opened. To prevent overtravel of the piston, there is an arrangement of floating levers as shown in Fig. 3, which is a cut of the Curtis Extraction device. An absolute essential in all turbine bleeder systems is the provision of a suitable check valve between the bleeder outlet and the system into which the steam is bled, to prevent the possibility of the steam from the heating system or other source, backing up into the 1st stage of the turbine and driving it as a mixed pressure machine, driving it to destruction should the turbine be lightly loaded. The writer has had the greatest difficulty in trying to make some operators understand how the turbine could be driven to pieces by low pressure steam through the bleeder connection and a few words on this point may not be out of place.

Necessity of Check Valve

Assume a turbine having a bleeder connection between the stages, and no check valve in the line. The bleeder being connected to the same system into which a number of reciprocating units are exhausting, the pressure being at, or near, atmosphere. The admission of live steam to the turbine being controlled by the governor of the high pressure inlet. Should the load be light the governor closes the high pressure admission valves, but the steam is entering the 1st stage through the bleeder, at a pressure which is equal to or greater than the normal 1st stage pressure at full load. There being no governor control on the bleeder line, the speed of the machine keeps on increasing even after the turbine governor has closed the live steam valves. The machine is now running entirely without control so long as the low pressure supply holds out. The speed is continually increasing until the emergency trips the main throttle valve, still the speed increases, since both the turbine governor and emergency are useless as far as any further control are concerned, and the only way to stop the turbine is to shut off the bleeder, but by the time the attendant realized that the machine was running away it might be too late to prevent its destruction.

In some installations there is a governor provided in the bleeder line as well as the high pressure inlet and the turbine can be operated as a mixed pressure machine, when conditions warrant, but those are special cases.

Dash Pot on Check Valve

The check valve in the bleeder must be provided with a good dash pot, that will absolutely prevent slamming, since the pressure is not steady in the bleeder system as a rule. The slamming of the check valve is aggravated by the pulsations of the exhaust of the reciprocating engines, when there are such, exhausting into the system.

Volume of Steam Extracted

It does not follow that when the pres-

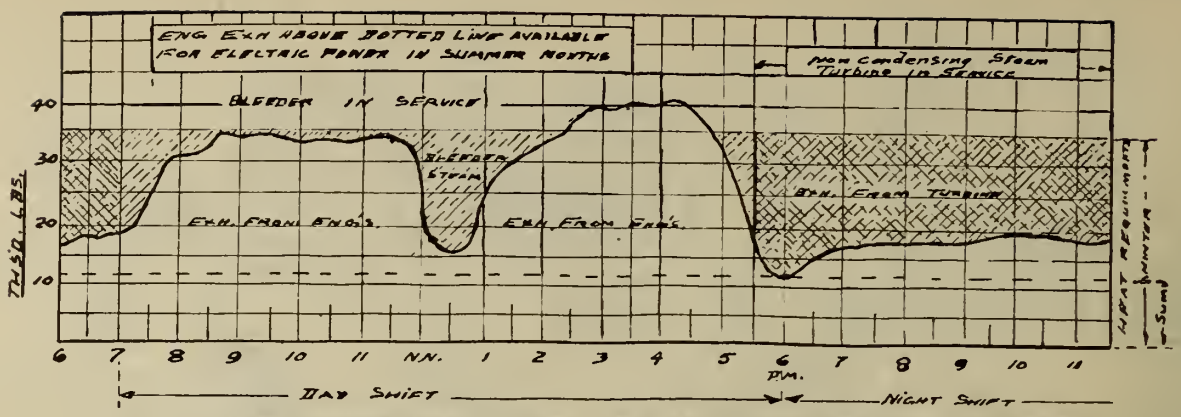


Fig. 4 — Chart showing actual average conditions in a 25 car plant using steam for drying of lumber and shop heating, operating at capacity in day time and 45 per cent. capacity night time. Note that the day work is at a maximum between 2:30 and 4:30 P.M. In summer months all the exhaust steam over the requirements of feed heater and dry kilns is used in the mixed pressure turbine for Electric power generation.

sure in the bleeder stage is constant that the volume of steam bled is constant. The volume of steam entering the turbine through the admission valves is a function of the load on the machine at that instant, as truly as though the bleeder did not exist, and the volume is constant, only so long as the load remains so, and is a maximum when the load is such that the 1st stage is doing all the work it can do at normal speed, with the ports to the 2nd stage entirely closed by the extraction device. That is all the steam admitted to the turbine is being bled to the heating system or low pressure system. The turbine is running as a single stage non-condensing machine except that by reason of the condenser, the 2nd stage wheel is revolving in a vacuum. Continuous operation under such conditions would not be justified, since it is very questionable if the benefits of the vacuum in the last stage would justify the operation of the auxiliaries, even if trimmed down to the lowest practical speed. However, such conditions exist for very short periods, if at all, in actual practice. The advantages or disadvantages of bleeding steam from a turbine lay entirely in the conditions existant where such operation is, or seems to be justified, and require special attention and advice from the builders of such types, who are always pleased to give the intending purchaser the benefit of their experience.

We will assume for convenience certain conditions of bleeder operation and discuss the question in such a way that it may be helpful to the man who has a bleeder turbine and who does not really know whether it is a good thing or not, or who does not know when it should be run as a "bleeder," "straight condensing" or "non-condensing."

When It Pays to Bleed Steam

Assume a 1000 K.W. two stage condensing steam turbine of the bleeder type, capable of carrying full load (1000 K.W.) when running non-condensing, using 16 lbs. of steam per K.W.H. at full load, and 23 lbs per K.W.H. non-condensing, assuming that the efficiency does not fall off much at ½ load, the consumption of steam per K.W.H. to be assumed for convenience at those figures for any load in excess of 50% capacity.

Let the load be variable between ½ load and full load, with the average about 75% capacity. The average steam

$$\text{cons. per hour} = \left(\frac{16 \times 1000 \times 17}{100}\right) = 12{,}000$$

lbs. per hour condensing, and

$$\left(\frac{23 \times 10000 \times 75}{100}\right) = 17{,}250 \text{ lbs. per hour}$$

non-condensing. If the requirements of the heating system are, say, 10,000 lbs. per hour at atmospheric pressure, by using the bleeder 10,000 lbs, go to the heating system and X lbs to the condenser.

The 10,000 lbs. bled is doing work at the non-condensing rate of 23 lbs. per K.W.H. and represents $\left(\frac{10000}{23}\right)$ of 750 K.W.H. = 435 K.W. The balance of the work is done at the straight condensing rate of 16 lbs. per K.W.H. and the total steam consumption is (10000+(750-435)) x 16=(10,000+ 5040)=15045 lbs. per hr.

$$= \frac{15045}{750} = 20.6 \text{ lbs. per K.W.H.,}$$

which is a saving at the turbine alone of 12.8% in steam consumption over non-condensing operation. Next assume that we desire to run straight condensing and bleed, the equivalent of the bleeder steam, from the high pressure line, where do we stand? Whatever steam is bled through the reducing valve will have to be charged up to the turbine operation for comparison.

Then

to—straight condensing operation 750 K.W.H. @ 16 lbs=12000 lbs per hr.

to—heating system $\frac{10000 \times (1150 \text{ B.T.U.})}{(1197.3 \text{ B.T.U.})}$

=9,600 lbs per hour

Total chargeable to condensing operation 21,600 lbs per hour.

$$= \frac{21600}{750} = 28.8 \text{ lbs. per K.W.H.}$$

It works back to the turbine operation as follows, for the three different methods, in the order of their economy, they are:

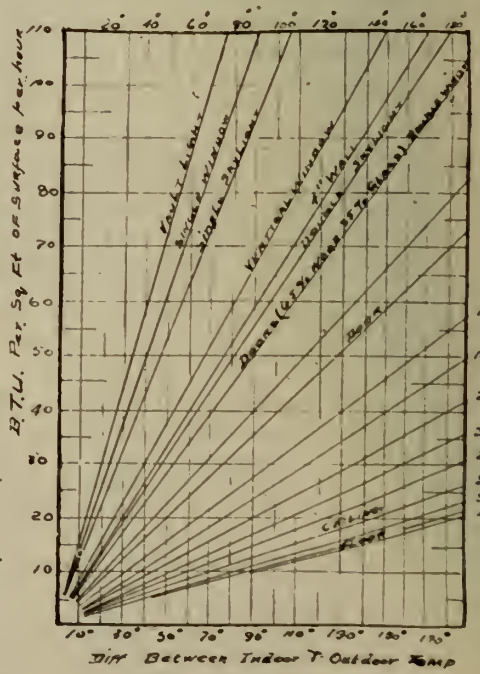
Bleeding operation 20.6 lbs. per K.W.H. =100%.

Non-condensing operation, 23 lbs. per K.W.H.=112%.

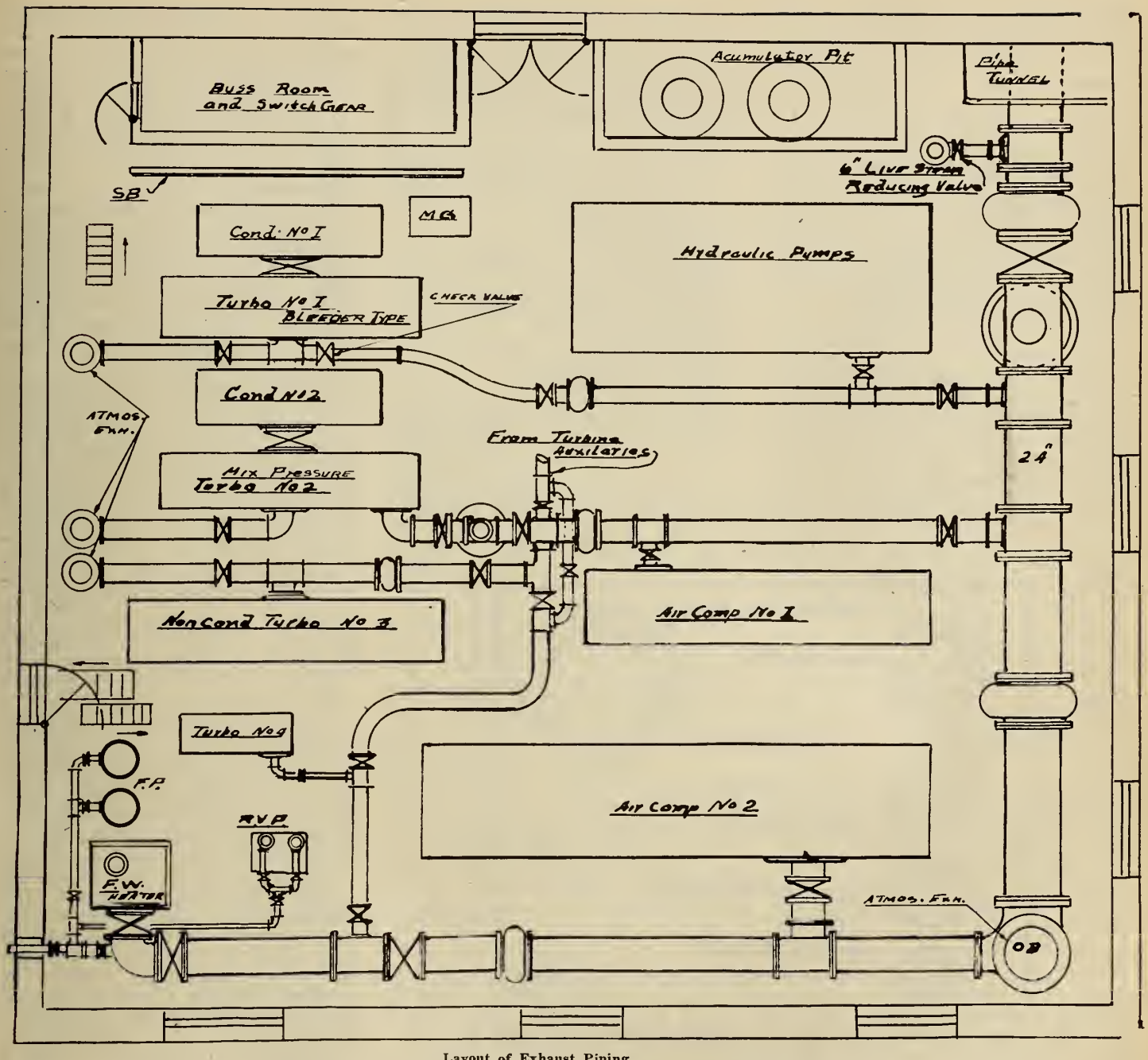
Straight condensing and bleeding from the main for heating system, 28.8 lbs. per K.W.H.=140%.

It can be seen that what would appeal to the average observer as the best method is the most extravagant. Bleeding steam from the turbine under the above conditions is 12% more economical than non-condensing operation and 40% more economical than straight condensing.

The foregoing demonstrates that when the requirements for heating exceed or are equal to the consumption of the turbine when run non-condensing, that it pays to run straight non-condensing, When the requirements are less than non-condensing steam consumption, use the bleeder. Even for small quantities it will pay to bleed steam, provided the



Showing Heat Transference.



Layout of Exhaust Piping.

bleeder pressure is not far from atmospheric pressure.

Effect on Efficiency When Bleeding Steam

It will be argued by the engineer at first that the fact of the bleeder (even if not bleeding steam or at least large amounts) being in service greatly reduces the turbine efficiency. That is, that the drop of efficiency will offset the benefits accruing from bleeder steam. Well, let us see what that argument amounts to.

So long as the steam is taken from the 1st stage, without doing any work in the 2nd stage, there is a falling off of about 45% in the efficiency of the turbine, but if the stage pressure is increased and no steam bled, but is admitted to the next stage at a higher pressure and expanded to the condenser pressure the efficiency of the 1st stage is less, but that of the next is greater. This statement is not absolutely correct in practice, but is theoretically correct and is sufficiently correct in practice to refute the argument.

Referring again to the elementary theory of the steam turbine as set forth elsewhere, we shall demonstrate that theoretically there is no drop in the overall efficiency of the turbine when the 1st stage pressure is increased, the total heat drop to be the same.

First:—A two stage or multi-stage turbine working between the limits of 175 lbs gauge, and 2 lbs. absolute the work is proportional to the heat drop, and the work per stage (theoretically) proportional to the heat drop per stage.

For the conditions of the 1st case $E=(H_1 - Hn)\ W \times 778$ for convenience assume 1 lb. of steam, then total work $E=(H_1 - Hn)\ 778 = (1197.3—1115)\times 778 = 64029.4$ ft. lbs. The work per stage $= \left(\frac{64029.4}{2}\right) = 32014.7$ ft. lbs. and the corresponding 1st stage pressure is 5 lbs. gauge (in practice it is less) say that the normal 1st stage pressure is zero gauge pressure, the drop in the 1st stage will be 46.9 B.T.U. and 36 B.T.U. in last or 2nd stage.

Second:—The same machine working between the same limits of pressure except that the 1st stage pressure is increased to 5 lbs. gauge

E per stage = heat drop per stage = (1197.3—1156.2) = 41.1 B.T.U. in the 1st stage and (1156.2—1115)—41.2 B.T.U. in the last and the total work = 82.3x778 = 64,029 ft. lbs., the total work is the same in both cases, but the 1st stage efficiency is reduced 13½%, while the 2nd stage is increased 13½%.

The expression $E=(H_1—Hn)\ 778$ is not quite correct when referring to the

steam turbine since the energy of the steam is given up in imparting velocity to the steam itself, and the expression $W(V^2)$ becomes $E=\frac{}{2g}$, but since the work is proportional to the heat drop there is nothing wrong with the statement.

Working it out the other way we must first find the velocity of the jet which varies as the square root of the B.T.U.

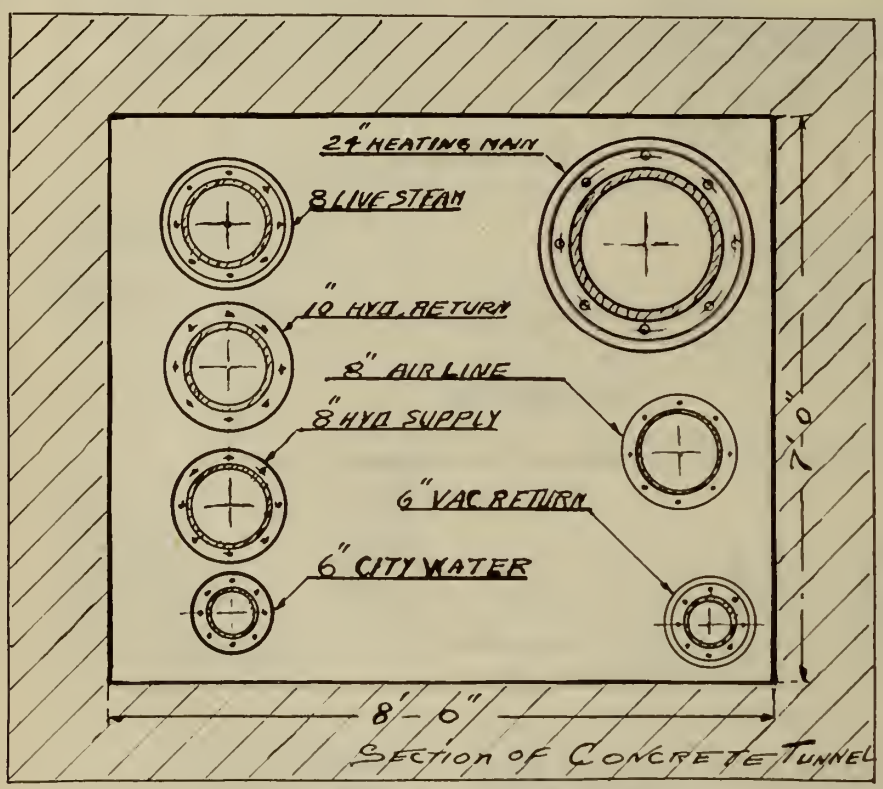
Then $V=224\sqrt{(H_1-H_n)} = 224\sqrt{82.3}$. or heat drop.

$V=(224 \times 9.07) = 2032$ ft, per second.

If the quantity considered is one lb. per second the energy available

$=(\frac{1 \times 2032^2}{2 \times 32.16})=64{,}195$ ft. lbs. per second.

I think I have shown that, theoretically at least, the argument that the turbine efficiency as a whole is reduced by increasing the 1st stage pressure is unfounded, as long as this is done within reasonable limits.



Showing Section of Concrete Tunnel.

I would like to suggest to the readers of Power House who have bleeder turbines, but who do not use the bleeder, because it is found that the exhaust steam from the reciprocating units just about maintain sufficient heat, in the plant, but who may be troubled with varying conditions affecting the steam consumption of the engines in such a way that the heating system pressure is fluctuating, sometimes between wide limits something like Fig. 4. The bleeder could be used to flatten the humps and fill the holes in the curve, giving ideal heating conditions, represented by a straight or flat curve. I think I have demonstrated that the fact of leaving the bleeder in service for just such purposes has not the bad effect on the turbine economy generally supposed, provided the turbine is designed for bleeding.

Now that we have had a discussion of the bleeder turbine I will pass on to a brief description of a heating plant where bleeder turbines form part of the equipment.

The heating requirements of the plant in question are in the winter months about as follows:

Ave. winter months—	
Dry kiln for lumber drying ave. ....=	14,000 lbs. per hr.
Shop heating (main plant) 1100'x500' =	16,000 lbs. per hr.
Hot blast vento system vac. returns	
Outbuildings, offices etc., inc. foundry offices, valve houses, etc..... ....=	8,000 lbs. per hr.
Feed water heating....=	6,000 lbs per hr.
	44,00 lbs. per hr.

To supply this amount of steam the available exhaust from the reciprocating units is

Day time—	
Auxiliaries.. ....=	3,000 lbs. per hr.
Compressors ....=	18,000 lbs. per hr.
Pumps.... ....=	8,000 lbs. per hr.
Fan engines ....=	2,400 lbs. per hr.
Hammers, etc. ....=	4,000 lbs. per hr. (about)
	35,400 lbs. per hr.

Due to the great length of the lines and the corresponding chances for loss, the exhaust supply does not really amount to more than approx. 30,000 lbs. per hour, leaving a deficiency of 14,000 lbs. to be made up by bleeding steam from the turbines, or from the high pressure main.

The supply of exhaust steam is somewhat variable, especially that from the pumps and compressors. While the pressure on the heating system must be kept fairly constant, owing to the extensive use of thermostatic traps in use at many points and the urgent necessity of maintaining constant temperature in the dry kilns.

The pressure carried on the heating main is 2½ lbs. approx. The returns being connected to a vacuum return system, in which a vacuum of 2" to 3" is maintained. The efficiency of a vacuum return system can be understood when it has been demonstrated in this plant, that steam at ½ lb. gauge can be circulated through 7 miles of 1¼ inch pipe, in an almost horizontal run.

In the day time the bleeder is used to fill the deficiency of the amount of exhaust steam, but in the night time there is only about 45% of the work going on and the available exhaust is depleted to that extent, which leaves a shortage of about 25,000 lbs. per hour. This amount cannot be supplied from the bleeder, since the turbine "night load" is so light that it is out of the question to depend on the bleeder, so at night the turbine is operated non-condensing, exhausting into the heating main, and any further shortage made up from the live steam line through a reducing valve.

There are short periods throughout the day, "when the bleeder supply plus all the available exhaust is insufficient for heating," when the live steam is brought into play. Fig. 5 shows the approximate conditions of load during the day run. The available exhaust steam varies almost directly as the load, "the load on all the units varying alike." It can be seen that the maximum supply is available during the hours when the outside temperature is highest, and diminishes toward evening when the outside temperature is falling off, during those periods it is the duty of the heating system attendant to endeavor to concentrate the heat on the points most requiring it, and to see that all doors are closed. Every artifice is resorted to until the exhaust steam supply is again a maximum.

The opening of doors is the most serious detriment and explains the large amount of steam required for shop heating. The doors must be opened frequently to permit the movement of trains of cars in and out of the shop.

The live steam reducing valve comes automatically into service when the pressure falls off in the heating system. The bleeder maintains the pressure at ½ lbs. up to the bleeder capacity, which, of course, depends upon the load on the turbine, when the pressure in the heating system falls off to about 2 lbs, the live steam reducing valve goes into operation. The reason for the difference in the setting, or adjustment, of the bleeder and the live steam reducing valve, brings out another interesting point.

Lag of Reducing Value

Should the live steam reducing valve be set at 2½ lbs. and the bleeder ad-

justed for the same pressure, the supply would be furnished by the live steam line up to the full capacity of the reducing valve. At the same time the bleeder turbine would furnish no steam, but would be operating with 2½ lbs. pressure in the 1st stage. That is when the reducing valve is between the bleeder and the heating system "as is often the case," there is no drop of pressure from the bleeder to the point at which the reducing valve is maintaining a given pressure corresponding to the bleeder adjustment, and consequently no flow. This fact must be remembered when using a combination consisting of bleeder, turbine and live steam turbine valves.

Exhaust Piping

A diagram of the exhaust piping and valves is shown in Figs. 6 and 7. It will be noted that many combinations are possible in this plant, the most interesting of which is the operation of two separate turbines as one unit, if desired. A test made on the combination of the Westinghouse and mixed pressure operating as a single unit, with the live steam throttle of the mixed pressure tight, showed surprisingly good economy.

The combination was not thought out by the plant designer but is the result of circumstances arising out of the difficulty of securing equipment during the war. At the time when more electric power was required it was impossible to get delivery on new equipment at short notice Cost being a secondary consideration at that time, it was decided to purchase the Westinghouse machine, and run it straight non-condensing if necessary, until such time as a condenser could be installed, but the results of the present combination were so satisfactory that the condenser part of the proposition was set aside. The combination will operate as a 1500 K.W. unit with a steam consumption of about 17 lbs. per K.W.H. at full load, and by the addition of another row of buckets on the rotor of the Westinghouse, "for which provision is made," the combination can be made more economical yet, if desired. However as the exhaust steam requirements for heating in winter months are in excess of the supply from the reciprocating units the arrangements are quite satisfactory for the present. In the summer months the surplus exhaust steam is used by the mixed pressure machine, which is operated on day service for about seven months in the year.

The apparatus for the heating system consists of the following:

"Dry kilns"—one of which is shown in Fig. 8, are heated by 1¼" pipe coils, of which there are approximately seven miles, representing a heating surface of $\left(\frac{7 \times 5280}{3}\right) = 12{,}320$ sq. ft., maintaining a constant temperature of 160 deg. Fah. in the kilns. The condensation is returned to the feed water heater by a return vacuum pump.

"Shop Heaters" consist of Vento C. I. heaters two stacks high and six sections deep in groups of two (8 heaters in all) one of the groups shown in Fig. 8. The supply connections to the heaters are 7" diameter. The riser shown in Fig 8 is 10" with 7" branches to each heater. The air is drawn through the heaters by an 84" Sirocco fan 100 R.P.M. driven by a 12" x 12" Rob. engine (see Fig. 9.) The exhaust from the engine is delivered to the heating system.

The air flows through the heaters at approximately 1200 ft. per minute, producing a heat transference of about 12 B.T.U. per sq. ft. of heating surface per degree difference of temperature Each heater consists of approximately 1680 sq. ft. of heating surface, there being 8 heaters in all maintaining a temperature of about 65 deg. in the shop, at an average condensation rate of nearly 21,000,000 B.T.U. per hour. The size of the shop thus heated is 1100 ft. long by 500 ft. wide, with concrete walls, no floors and wood roof. The exposure to the weather is approximately 650,000 sq. ft. of surface, a great deal of which is glass and doors, the latter left open a lot of the time. The temperature in the shop is regulated by varying the speed of the fans, which varies the rate of heat transference at the heaters.

The condensation from the whole system is returned to the feed water heater at a temperature of about 180 degrees Fah. The return at the vacuum pump are approximately 200 degrees Fah. A spray pipe in the last section of the return line condenses the vapor. The spray water is, of course, mingled with the returns to heater.

The chart Fig. 9 shows the heat transmitted per hour through various substances. While rather unsatisfactory for shop heating problems of the class where numerous doors are opened and left open it is nevertheless instructive. The chart was prepared by Mr. R. Wolfe, M.E., of New York. From a study of the chart it would appear that 40 B.T.U. per hour per sq ft. of building wall when the outside temperature is 70 degrees is very conservative, for most large shops and for shops such as the one of which I write, the requirements will not fall far short of 60 B.T.U. per sq. ft. of exposed surface per hour at times, for instance, the average in this shop required for heating during at least four months of the year is approximately 21,000,000 B.T.U. per hour, with the maximum at about 32,000.000. There are about 650,000 sq. ft.. of outside wall, including roof, but no floor, and $\frac{32{,}000{,}000}{650{,}000} = 49$ B.T.U. per hour based on exposed surface to maintain 65 degrees in zero weather.

Troubles Encountered

Every extensive heating system has some few minor drawbacks peculiar to itself, and require special attention. The most common in large systems, the return vacuum type, is short circuiting of the system. This is partially remedied by the use of thermostatic traps, but the trouble has not been entirely eliminated, due, of course, to the difficulty of keeping the traps in proper order and the presence of scale and dirt which collects in an extensive system, and this is one of the greatest difficulties encountered in the operation of the system which is described here.

INDUSTRIAL RESPIRATORS

Before the war, respirators specially designed for use in industry were, practically speaking, non-existent. Experience with respirators as protection against poison gas during the war, however, has been turned to good account from the industrial point of view and Dr. Leonard Levy, at a recent meeting of the London Section of the Society of Chemical Industry, gave an account of latest developments that have been made in the face-piece of respirators over the type used in the Army, but the canisters employed are unused small box respirator canisters of the type used in the Army, which it has been found difficult to improve upon, and, moreover, they happen to be readily obtainable in large quantities. The fillings of the canisters, however, are quite different from the Army fillings. For industrial purposes, there are now ammonia respirators, which find extensive application in cold storage plant, and for which the most satisfactory absorbent has been found to be crystalline copper sulphate.

The next type gives protection against neutral vapors, such as hydrocarbon fumes in oil fields, cleaning out oil tanks, etc., and here the best results have been obtained with a filling of highly activated vegetable charcoal. A third type is designed to deal with acid gases, such as hydrochloric acid, chlorine, sulphuretted hydrogen, phosgene, sulphur dioxide, nitrous fumes, hydrocyanic acid, etc., and in this case it has been found that a uniform mixture of alkaline granules and charcoal has the longest life. The alkaline granules made use of by the author are slaked lime, diatomaceous earth, ferric hydroxide, and activated charcoal. Finally, there is the carbon monoxide respirator, which has presented many novel problems, because there is no known absorbent suitable for use in a respirator canister for the removal by chemical absorption of carbon monoxide. A thoroughly effective method ed with this gas. An effective method, however, is by the catalytic oxidation of the carbon monoxide by the oxygen of the atmosphere, using certain special mixtures of oxide, such as finely divided manganese dioxide, copper oxide, cobalt oxide and silver oxide. Moreover, as carbon monoxide gives no indication of its presence, it is necessary for a detector to be embodied in the respirator, so that the wearer can be warned if the respirator has accidentally failed.—Compressed Air Magazine.

How to Make Use of Logarithms

The First of a Series of Articles Showing How to Learn the Use of This Method of Shortening Long Calculations. It Will be Continued in Consecutive Issues.

By T H. Fenner

NOW that the Ontario Board of Stationary Engineers allows the use of logarithms in making calculations, there are many engineers who would like to avail themselves of the help that logarithms afford. In making calculations involving long multiplication sums, the work is very much shortened, and a much greater degree of accuracy made probable, owing to the lessening of the liability of error in handling large quantities of figures.

A logarithm, usually called by the abbreviation log, is really a power to which a certain fixed number must be raised in order to produce the number required. The fixed number is known as the base, and may be any number at all, but in the system in general use, known as common logarithms, the base is 10. That is, to obtain any number at all, the base of 10 must be raised to a certain power, which may be a whole number and a fraction, or simply a fraction. Before studying the subject of logarithms, it would be well to study a little the theory of indices, which will enable the student to better comprehend the system on which logarithms are calculated.

Supposing we have a number which is to be raised to the power of two, or in other words squared. That is, the number is to be multiplied by itself. If we set this down in the ordinary way, it will appear, supposing the number is 2, as 2×2, which is 4. Now the first power of 2 is 2, and the second power of 2 is 4. Thus we may say that 2 to the first power, multiplied by 2 to the first power, is 4. Now suppose we take a letter instead of a number, and say a is to be multiplied by a. The product will be a^2. Now, how do we get the second power? We get it by adding together the index figures of the power of the multiplier and multiplicand. Although we do not put in the index figure, which is 1, we imagine it is there, and our sum would appear as:

$$\begin{array}{r} a^1 \\ a^1 \\ \hline a^2 \end{array}$$

Now, if we have, instead of $a \times a$, we have $a^2 \times a^2$ the result would be a^4. Thus we should have $a^1 \times a^1 \times a^1 \times a^1$ which would give a result of a^4. Now if we have $a^3 \times a^3$ the result would be a^5 and if we have $a^2 \times a^4$ we should have a^6.

For instance, the first case would be $a \times a \times a \times a \times a$, and the second case would be $a \times a \times a \times a \times a \times a$. Now let us substitute instead of letters, figures. Suppose we have 2×2, the result will not be 4, but 2. The sum would be

$(2 \times 2) \times (2 \times 2 \times 2)$
$= 4 \times 8$
$= 32$

Now, if we multiplied the figures and added the indexes, we would get $2^2 \times 2^3 = 4^5$ which would be entirely wrong. However, we see that if we wanted the power to which the number two would have to be raised to give 32, it would be 2^5.

This leads to the rule, that when a literary quantity, that is a letter, is multiplied with another letter, the indexes must be added together to give the index of the quotient. Now if you have a quantity like $2a^2$ multiplied by $2a^2$, the answer would be $4a^4$. That is the index of the letters would be added together, but the numbers would be multiplied in the ordinary way. Supposing now that the quantity was enclosed in a bracket, thus (2a), with the index outside the bracket, then this would mean that the whole quantity in the bracket would have to be raised to the 2nd power, and the answer would be 4a. Now if we had two of these quantities enclosed in brackets with the multiplication sign between them thus, (2a) x (2a) the answer would be 4a 4a.

This is arrived at as follows:—Take the first bracket, we have as a result $4a^2$, and this has to be multiplied by $4a^2$. 4×4 is 16, and $a^2 \times a^2$ is a^4, and the sum would appear in detail like this

$(2 \times 2 \times a \times a) \times (2 \times 2 \times a \times a)$
$(4 \times a^2) \times (4 \times a^2)$
$16 \times a^4$

and as 16 to 4^2 the answer would be 4^2a^4. Now if we were to take the figure 2 as the base of a series of logarithms from which we could determine any number by merely raising it to certain powers, we would find that these powers would be largely fractional. Thus if 2^2 were 4, and 2^3 were 8, then 2^4 would be 16. Now suppose we wished to find a number that lay between 8 and 16, it is evident that the power to which we would have to raise 2 would be a power lying somewhere between the 3rd power and the 4th power. The power required would be 3 and some fraction. Now if we were to denote our base 2 by a letter, say a, then to get the number required we should have to multiply the letter a by itself, and add the index of its first power plus a certain fraction together to get the number required. Thus if we wanted the third power of a, we should have $a^2 \times a$ which would give us a^3, and if we wanted the fourth power of a we should have $a^2 \times a^2$. If we want a power between the third and fourth power we should have to multiply $a \times a$, each raised to a power of one and a fraction. Thus if we wanted a number corresponding to the $3\frac{1}{2}$ power of two, we should have $a^{1.75} \times a^{1.75}$, which would give $a^{3.5}$ and the base raised to this power would be the number required. Now the common system of logarithms is a series of powers to which the fixed number or base must be raised to give any number required, only the base on which these powers are calculated is 10, and not 2 as we have stated. As the base is a fixed number, in the tables of logarithms it is not given, all that is given being the index of the power corresponding to the number. Now we have seen that when we multiply we are adding together the indices, it follows that if we know the indices corresponding to any number, and want to multiply, all we have to do is to add the indices of the two numbers together, and we shall get an index corresponding to a number which will be the product of these two numbers. Similarly, if we wish to divide, we shall have to subtract these two indices, to get an index which will be the index of the quotient of these two numbers. That is the theory on which the logarithmic table is based.

Base of Common Logs

Now the base that is used for the common system of logarithms is 10. The logarithm of 1, no matter what system is used will be nothing, for it is quite evident there can be no two indexes which added together would give an index corresponding to 1. If the base of the logarithm is 10, the logarithm of 10 will be 1, that is the index of the power to which it would have to be raised to give itself would be 1 or 10×1. Now the logarithms of all numbers between 1 and 10 must be fractional quantities, for the log of 1 is nothing, and the log of 10 is 1. The log of any number between 10 and 100 will be 1 and a fraction, because the log of 100 is 2, that is the power that 10 must be raised to in order to give 100 as the second power. Between 100 and 1000 the log of any number will be 2 and a fraction, because the power to which 10 must be raised in order to give 1000 is three, thus $10 \times 10 \times 10 = 1000$. So we get for each multiple of 10 an increase of 1 in the index figure, that is in the integral number, not in the fraction. That varies with each number. We can now proceed to define a little closer just what a logarithm consists of.

Characteristic and Mantissa

We have said that every logarithm consists of either a fraction or a whole number and a fraction, or a whole number. The integral part, or the whole number of a logarithm, is called the characteristic of the log, while the fractional part is called the mantissa. Thus the log of 10 would consist of a characteristic, while the mantissa would be .0000000. The log of 1 would be .0000000, while the log of 100 would be 2.0000000. It is usual to carry the fig-

ures of the mantissae to seven places of decimals, in the interests of accuracy, but in many tables they are carried only to four places. From what has gone previously, it will be seen that there is a very simple rule by which the characteristic of the log of any number can be determined. The characteristic will always be one less than the number of figures in the number whose log is required, or in the number of figures into the left of the decimal point where there is a decimal fraction as well as a whole number.

When the number whose log is required is between 1 and 10, there will be no characteristic, the log consisting of a mantissa only. When the number whose log is required is a decimal number, then the characteristic will be a negative quantity. Thus the log of 20 is

1.30103

the log of 2 is

.30103

and the log of .2

$\bar{1}$.30103

The minus sign is written above the characteristic instead of preceding it as is usual in the ordinary way.

When the figure immediately following the decimal point in the number whose logarithm is required, that is of course a fractional number, such as .02, the characteristic of the logarithm will be —2 and the log would be written

$\bar{2}$.30103

and the log of .002 would be

$\bar{3}$.30103

and so on, every cipher following the decimal point adding one to the characteristic of the log, which is always a negative quantity.

In the ordinary tables of logs, the characteristic is not given, the mantissa alone being shown, and the decimal point omitted. This simplifies the table, and there is no chance of going astray on the right characteristic, if the rule is clearly remembered. That is the characteristic of the log of a whole number and fraction, or a whole number is always one less than the number of figures to the left of the decimal point in the number, and the characteristic of the log of a fractional quantity is always a minus quantity, beginning at minus 1 when an integral figure follows the decimal point, and adding one for each cipher that follows the decimal point, and adding one for each cipher that follows the decimal point before an integral figure is reached.

We will follow up this article with further ones in which examples of the working of logarithms are given, and the method of reading the table shown. If every engineer was aware of the help it would be to him to be able to calculate by this method, he would devote a little energy to learning it. A little practice is all that is required to enable any man to become quite familiar with the method, and further more there are some calculations that cannot be made very well without the use of logarithms. Take for instance the formula for finding the mean absolute pressure when the initial pressure, initial volume and final volume are known, which is as follows:

$$Pm = p^1 \frac{1 + \log.e.R}{R}$$

where Pm = Mean abs Pressure
p^1 = Initial abs Pressure
m R = Ratio of expansion ($v_2 \div v$)

(To be continued)

UNIQUE ELECTRIC TRAVELING CRANE

When the first electric traveling crane was built, the builder in all probability did not realize the tremendous possibilities that were opened up for a material-handling appliance of this nature as a labor saving device, and the economical advantages which were to be gained by its use. The diversity of applications of the electric traveling crane and the variety of materials which it will handle to advantage are too numerous to mention here.

One unique application may be seen at the Power Plant of the Union Gas and Electric Company at Cincinnati, Ohio. This crane which was built by the Whiting Corporation, Harvey, Ill. according to specifications issued by Sargent and Lundy of Chicago, who were the Engineers on this work, served as a dredge for an intake well of river water for cooling turbo-generator condensers.

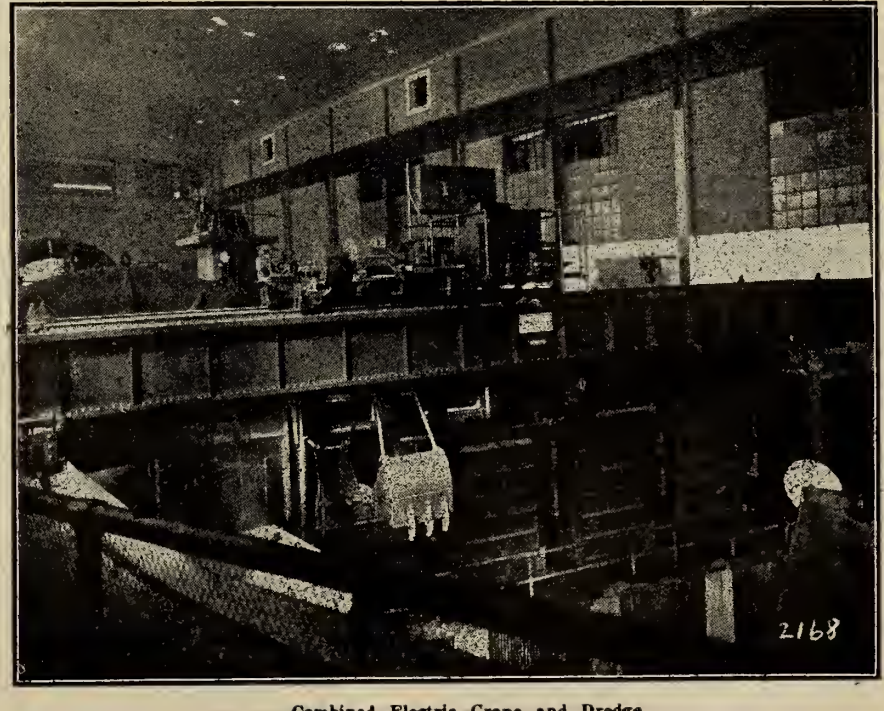
Water is supplied from the Ohio River to the intake well through tunnels and is first cleared of water-logged debris and silt by means of a heavy bar iron grill before reaching the traveling screens behind. This debris and silt is removed from the bottom of the well by means of a grab bucket operated by the crane, and deposited into a hopper. This grab bucket is often called upon to remove heavy water-logged objects such as tree trunks, and it may incidentally be mentioned that on one occasion it brought up a dead cow, very much bloated, from the bottom of the well.

The shape of the intake well is that of a sector of a circle. The crane spans the well radially, having one end truck pivoted at the center of the circle (rotating on a roller bearing at this point), its other end truck traveling on a circular track at the outside edge of the well. This truck is fastened directly to the floor at this level, and a pipe railing is provided around the crane and the operating mechanism of the traveling screens as a safety measure. The crane trolley with its suspended bucket travels along the entire length of the crane bridge or as far in towards the center of the circle as efficient operation of the bucket will permit. The operator's cab is fastened to this trolley extending above the top of the bridge girders and in such a manner as to give the operator an unobstructed view of the bucket and well.

The span of the crane is 49 ft. 10 in., and the trolley is designed for a lift of 100 ft. of the grab bucket which is of ¾ cu. yd. capacity. Two motors of 7½ H. P. each operate the bridge and trolley travel respectively, and two 45 H. P. motors operate the bucket hoist, each one of these motors being equipped with an electric brake.

NEW FORMULA

The Du Pont Company has developed and perfected a formula for the manufacture of straight dynamite which results in that explosive being proof against freezing even in zero temperatures. As a consequence of this development, they have determined to discontinue the manufacture of their former straight dynamite and hereafter all this kind of explosive will be made by the new low-freezing method.



Combined Electric Crane and Dredge.

Welding of a Caulking Edge on a Boiler or Tank

It Pays to Know More Than the Regular Routine of Work—Putting Refractory Plates and Angles in Place—Building Up a Broken End of a Shaft

THE welder who knows only the regular tasks, never goes far. He may hit up against some difficulty, and it is then that his resourcefulness is under test. The matter to follow illustrates and explains some interesting and useful welding dodges, so that those interested in this branch of the business should read each hint carefully, remembering them for future occasions.

For example, Fig. A shows a method of making a lapped plate joint where the edges do not come together flat or the plate bulges between the means provided to hold them together, such as a few bolt holes spaced some distance apart. Another use for this scheme is getting refractory plates and angles in place in ship barge work and perhaps later this scheme will be used in large size ships. The idea is simply to tack a bolt by its head upside down on the lower or inner plate, tacking it by single fillet across two edges only. The heavier plate used as a clamp is then brought down with a nut to bring the upper or outer warped plate into place. After this plate is tacked down and nut can be removed and the bolt knocked off at right angles to the weld or if this proves troublesome, one of the welded beads can be chipped off and then the bolt head can be knocked loose pushing from that direction. This method should be acknowledged to Mr. W. T. Bonner, who devised it and first used it in ship work.

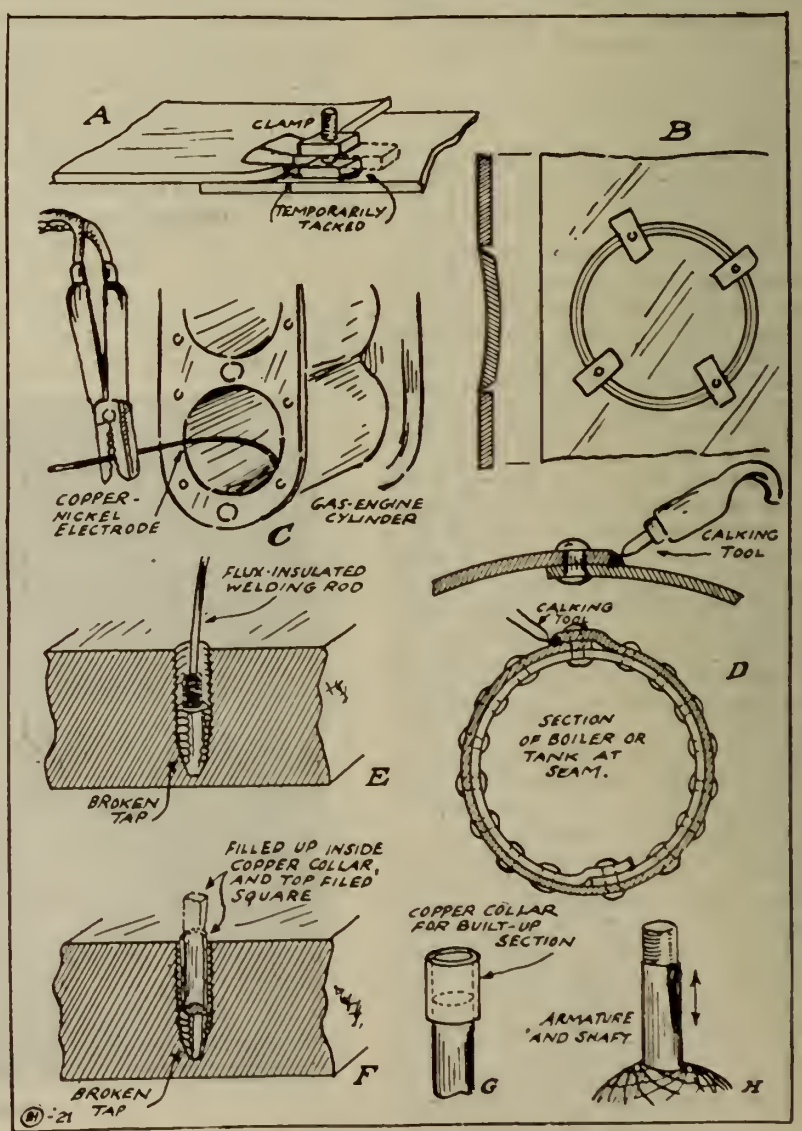
Illustration B shows a method of putting in a patch in a plate whether a plane, round or warped surface where much trouble has been experienced in keeping a welded patch from cracking during the welding or after welding or in service or where from experience such danger is liable. In the cross section you will note the patch is slightly dished, the idea being that the contraction during welding will just about take up the dishing and straighten out the plate that is used as a patch relieving all strains. The ideal patch in this case is a circular one but oft times a true circle cannot be arranged for but the nearer a circle is approached the better the chances are for success. For instance, if the hole is rectangular, rounding the edges will help a whole lot and if the hole is odd shaped, making it an ellipse or egg shape will approximate the circle where the stresses are even all around.

Where a machine formed dished patch cannot be obtained an ordinary sheet can be dished by hammering. If the sheet is over ¼ inch thick it should be hammered hot and it is best hammered hot for any thickness.

The four clamps show an easy method of holding the plate in place, simply putting a bolt through from the inside and clamping down with a heavy plate and nut on the outside. These clamps should be left in place as long as possible in this rigid system of welding. This system not being at all applicable to the non-rigid system as it is a rigid weld with the stress tranferred to the dished patch.

Fig. D shows an apparently easy job to the initiated, that is the welding of a caulking edge on a boiler or tank. This job is far from being easy, because in most cases the welder is called to fix up a leaky seam and the cause of a leaky seam is movement of the plates or rivets. Simply running a caulking edge along the joint will in general make the seam tight when not in use, but upon the boiler tank being put in service, especially under pressure, the plates are liable to assume a different shape or position under load than when quiet, the strain then being entirely brought upon the weld whereat it is broken or pulled away, adequate provision not having been provided to equal the strength of the plates to which it is welded.

It is not always the correct thing to do to make this weld stronger than the plate. In a boiler, for instance, where rivets have been installed for part of the seam, it is best to fire up the boiler and put it under full pressure, thus straining it into its final position before welding. Illustration D shows how a caulking seam should be approached with the tool so as not to drive the weld under the plate. A great deal of experience is needed in caulking for arc welding just as caulking experience is



Sketch shows the various ideas suggested in text matter.

Extracted from a handbook published by the Electric Arc Cutting & Welding Co., Newark, and reproduced through the courtesy of said company.

needed for rivet work. Every boiler maker knows that an amateur will do with a caulking tool more harm than good and similarly in welding; too much caulking is harmful instead of beneficial. A multiplicity of light rapid blows is the only reliable caulking method on a weld, whether the caulking is for a smooth finish or to make the surface denser against weeping. Also, too much caulking will cause the surface of the weld to crumble and repeated caulking of this nature will finally result in crumbling the welding all away.

Caulking rough looking welds for a finish is common practice, but in this case the rougher part of the weld must be chipped or ground approximately the size before caulking, or the efficiency of the weld will be much lowered, both as to strength and tightness. Working a weld cold except on the surface would be similar to working a sheet cold of similar dimensions which could be easily cracked or ruined. Working the weld hot is a different matter, but it is almost impossible to caulk metal arc welding while hot, although in many instances on very careful work each inch or two is caulked while hot (just after it is put down) with a ball peen hammer in the hands of the welder. In very few instances the weld can be reheated and caulked but these are very scarce as reheating would in general cause more strain and stresses than would be relieved by caulking.

Filling In Scored Cylinders

Illustration C shows the proper method of filling-in scored cylinders with the latest development, the copper nickel electrode, which has the property of so merging with cast iron that the usual hard spot underneath the weld is done away with. This copper nickel electrode is far better than the old pure nickel peened in, as the copper nickel can be welded in continuously; care being taken not to get the cylinder wall too hot, that is weld not over two or three inches at a time. The excess metal can be machined off with any common ordinary tool or a lathe or boring mill or can be ground nearly to size and can then be rolled and lapped afterwards.

The illustration shows the electrode bent so that the tip is approximately at right angles to the score to be filled. This is a repetition of previous instructions on this point, i.e. that no arc weld can be made properly unless the electrode tip is very nearly at right angles to the work piece surface. For this copper-nickel electrode even although the score is very small at least ⅛ inch size electrode must be used, as 130 amperes is about the smallest good value that will reliably weld the cast iron and a ⅛ inch electrode is the smallest that will carry this current. For larger work a 5/32 inch electrode is best.

Fig. E. and F. show two methods of reclaiming broken taps in thick pieces or castings, which method is not new by any means. There is nothing more exasperating than to break a tap, especially a bottoming tap below the surface of the main piece. The tap must be gotten out or the work is ruined. If the hole is large an insulated rod can be used to build up on the tap until it is above the surface where a square can be filed on it and tap backed out. The insulation on the rod helps to prevent spoiling of the thread by accidental contact. The method here is to weld a bit at a time or if you have become expert at dipping in and out of the puddle, the building-up can be made practically continuously by shorting the arc in the puddle and pulling away to a very short arc before the puddle freezes. This method is also very useful in building-up oft-times at other places than in a hole.

Where the hole is small an extra tube shoved down inside the threads will allow of the added metal being built-up to the surface in order to file a wrench grip to back out the tap. Illustration G shows a method of building up a broken or chewed off end of a shaft where the end is not more than 4 inches to 6 inches long. The copper collar is here banded on the inside, the collar being not more than 1½ or 2 inches higher than the welding surface at any time, being pushed up successfully as the building up progresses. This method is far better for short pieces than trying to weld on a piece as it does away with the necessity of veeing out, aligning, etc.

After the weld is made the copper collar should be removed and a finish made for subsequent machining by welding lengthwise of the shaft, similarly as is shown on the armature shaft, illustration H. These welds should always be made lengthwise of the shaft in order to ensure an even deposit because in welding around the other way the welding setting is only right for one position and is too hot for the vertical welding and not hot enough for the horizontal. This welding of armature and other shafts, by the way, where the bearing is worn or scored or the keyway is chewed out, is one of the most useful applications of arc welding, as there is practically no danger of putting heat enough into the shaft to melt adjacent babbitt or ruin adjacent windings.

The illustrations on the sheet and angle work show some special applications of joining two or three or even more of the regular structural members for structural work. When joining two plates at an angle, if the sheets are left a bit spread the pieces can be joined reliably in the one weld. The wider the plates are apart, the more reliable will be the joining of the inner three pieces and at no time should the plates be apart a smaller distance than their thickness. The illustration to the right of this shows a method of stiffening a sheet either for attaching to an upright or not.

The angle bending and welding method shown in the center top is one of the most widely used applications of arc welding but is shown as an idea to extend the arc as arc welding is only started. You will note that any angle can be allowed for by cutting out the V to correspond. The illustration to the left of this shows a method of joining by a combination of arc welding and bolts, members which must be removable. The window frame method itself is self explanatory, it being found much easier to chamfer off the window slightly than to make a flush weld and perhaps ending by having to chip the weld. The corner sheet method is similar to the joining of the three pieces explained at the start of this section. A weld made in this manner and finished off a bit is the prettiest joint yet devised.

Where an angle would be objectionable or the plates are small the weld can be butted on the outside at right angles and not welded at all or just welded for finish only.

Unique Method of Welding

A unique method of welding is shown left of this where a lapped joint must be made for a third member and the three of them joined. The illustration shows how one of the plates is nicked out and the other one laid over the notch half way the width of the notch so that the weld can be made through this opening to the third member, at the same time joining the two sheets. The sketch of the veed out plates is shown for several reasons, one that the angle of the "V" must vary with the thickness of the plate for an even flush butt weld, being thicker for heavy plates. In general, however, a right angle opening is the maximum required.

Welding long seams butted brings up the question of the rigid or non-rigid method. In the rigid method the plates are clamped or bolted in their final alignment and the weld made in any manner, either continuously or broken up to spread the resulting contacting stresses over more time and plate. In the non-rigid system the plate is placed close together at one end and the part at the other end and the weld made continuously closing in the opening at an even rate which will just bring the closed ends together at the finish of the weld. This method requires more skill and experience than the non-rigid and in any ordinary job is not worth the trouble it entails, although for very careful work it may be desirable to use it where joining two pieces only.

It is evidently more out of place in setting in a patch as the only part of the patch on which this method can be used would be the first seam. There is a use for it, however, even in setting in patches in some very rare cases where the difference between success and failure depends on getting the first edge of the seam perfect so that it will not be pulled away due to the contracting strains when welding the opposite seams or the seams at right angles which exert a more tearing pull than the opposite seams in contracting.

An aid which is hard to obtain but which has been found very useful in very careful work is to vibrate the work while making the weld by light blows of the hammer or vibrating the work directly after the weld is made, i.e., while it is cooling and contracting. The vibrations of an air hammer set for a light blow is the best means for accomplishing this.

How to Calculate Magnet Windings

Examples of the Mathematical Methods of Determining Number of Turns of Wire, Size of Wire, Loss Due to Rise of Temperature, and Heat Radiating Surface of Coal

By Terrell Croft (Copyright. All Rights Reserved.)

THE DESIGN of windings to excite electromagnets is a rather complicated subject. However, directions are given in following paragraphs whereby windings to satisfy ordinary conditions can be calculated. As in all other branches of engineering, experience is a great asset and is a necessary equipment of one who designs windings most effectively and economically.

Usually the number of amp. turns necessary to produce a certain flux is known, this number having already been estimated. The problem is then to determine the size wire to use for the winding and the number of turns for the winding so that, with a given voltage applied to the winding, a current will flow that will develop the required amp. turns. The winding must also be such that it will not heat excessively and that it will fit into the space prepared for its reception.

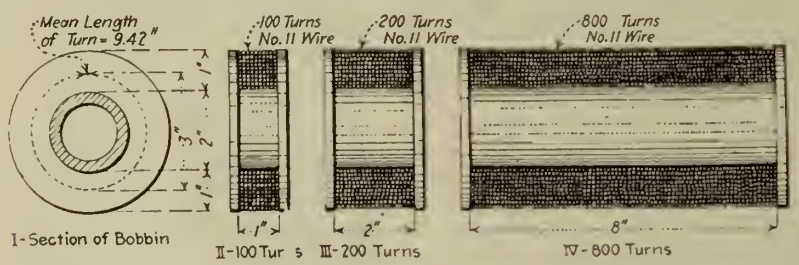


Fig. 1—Illustrating the effect of changing number of turns, the mean length of turn remaining constant.

With a given size wire, a given length of mean turn and a given applied voltage, changing the number of turns does not change the amp. turns. To change the amp. turns of a winding, with the conditions as above, it is necessary to either use a different size wire or to change the applied voltage. If a wire twice as large is used the amp. turns will thereby be doubled. If the applied voltage is doubled, the amp. turns will be doubled. The following example explains the situation.

Example

Consider the winding spaces of Fig. 1. The diameters of all of the spaces are as at I, hence the average diameter of coil or mean length of turn is, in each case, 9.42 in. Suppose that the 1 in. x 1 in. space of II is so wound with insulated wire that it will contain just 100 turns (No. 11 single cotton-covered wire, see a magnet table, will about meet this requirement). See note following for detail calculations. The resistance of the entire coil, 100 turns, in II would be almost 0.1 ohm. Assume that the impressed voltage is 1 volt. Then by Ohm's law, the current that would be pushed through the coil by this voltage would be:—I = E ÷ R = 1 volt ÷ 0.1 ohm = 10 anm. Therefore, the amp. turns of the winding would be:— 100 turns x 10 amp. = 1000 amp. turns.

Now if the coil were made twice as long, as at III, it would contain twice as many or 200 turns. But its resistance would also be twice as great. Hence, although the turns have been doubled, the current has been halved, hence the amp. turns, assuming the same applied voltage (1 volt) would remain 100. With the winding of IV, the turns are increased 8 times but the resistance is also thereby increased 8 times. Hence, ⅛ the current will flow and the amp. turns will remain 200.

Note

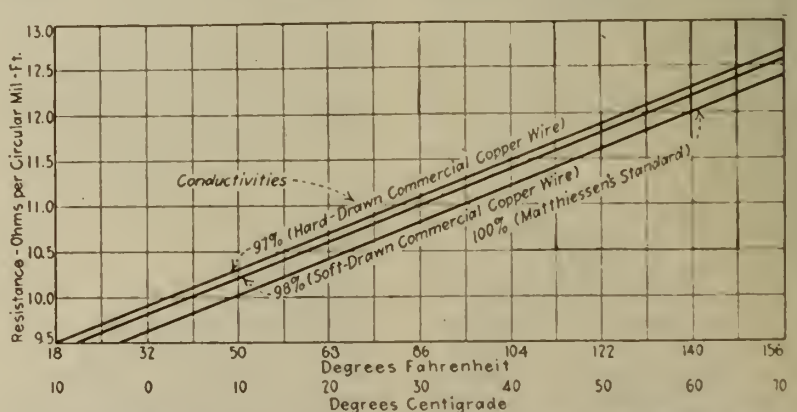
The resistance of the above-mentioned coil was calculated as follows:—The length of mean turn for I, Fig. 1, is 3 in. x 3.1416 = 9.42 in. If the 1 in. x 1 in. space of II is wound with No. 11 single, cotton-covered magnet wire it will contain just about 100 turns. The average length of each turn is:— 9.42 in. ÷ 12 = 0.79 ft. Then in the entire coil there are 0.79 ft. x 100 turns = 79 ft. The resistance of 1000 ft. of No. 11 wire is 1.26 ohms or the resistance of 1 ft. is 0.00126 ohms. Then the resistance of the entire coil is:—0.000126 ohms. x 79 ft. = 0.1 ohm—the value used above.

Increasing the number of turns in a coil having a given length of mean turn and with a given applied voltage decreases the heat developed by the coil. Decreasing the number of turns decreases the heat. Therefore, the amount of wire on a coil, the conditions being as above, determines whether it will operate hot or cool. The size of wire (see preceding paragraph) merely determines the amp. turns. The reason for this is that the heat developed by a current of electricity in any conductor varies as the square of the current. That is, watts heat developed always equals:—I^2 x R. Doubling the turns halves the heating. Other increases or decreases in the number of turns change the heating produced proportionately.

Example

(1) Assume a coil having 200 turns and, say, 20 ohms resistance. If this coil were connected across 100 volts, 5 amp. would flow through it. The heat developed in the coil would then be:— I^2 x R = 5 x 5 x 20 = 500 watts. (2)—Now consider another coil of the same size wire, and having the same mean length of turn, but wound with twice as many, or 400 turns. Its resistance will be twice as great, or 40 ohms. if connected across 100 volts. 2.5 amp. will flow through it. The heat developed by this coil will therefore be:— 2.6 amp. x 2.5 amp x 40 ohms = 250 watts. This is just half of the heat developed by the coil having 100 turns.

The working formula for the calculation of the size of wire for a magnet coil that will provide a required number of amp. turns when connected across a given voltage is the last one in this par-



Graphs showing the resistance per circular mil-foot of copper of different conductivities at different temperatures. (It is usual to specify that hard drawn copper shall have 98 per cent. conductivity and soft drawn copper 97 per cent. Hence commercial copper wire has about these conductivities).

agraph. Its derivation will be given:—

(1)

$$R = \frac{K \times N}{\text{cir. mils}} \times \frac{L}{12} = \frac{K \times N \times L}{12 \times \text{cir. mils}}$$

Wherein.—R=resistance, in ohms, of all of the turns of any magnet winding. K=a constant, (the resistivity of the metal of the conductor) numerically equal to the resistance in ohms of a cir. mil foot of the conductor of the winding. N=the number of turns in the winding. L=length, in inches, of an average turn of the winding—or the length of a mean turn. Cir. mils=cross sectional area of the conductor in circular mils.

If the magnet coil is to operate on some certain fixed voltage, as magnet coils usually do, the current through the coil will be, by Ohm's law, $I = E \div R$. Now substituting the expression for R obtained above in this Ohm's law formula, we have:—

(2)

$$I = \frac{E}{R} = \frac{E}{\frac{K \times N \times L}{12 \times \text{cir. mils}}} = \frac{E \times \text{cir. mils} \times 12}{K \times N \times L}$$

(amp)

Wherein.—I = current, in amperes, through the coil. E=electromotive force impressed on the coil, in volts. Now multiplying both sides of this equation by N, we have:—

(2a)

$$IN = \frac{E \times \text{cir. mils} \times 12 \times N}{K \times L \times N} \text{ (amp. turns)}$$

The two Ns in the right hand member of the equation cancel out giving:—

(2b)

$$IN = \frac{E \times \text{cir. mils} \times 12}{K \times L}$$

and it follows that:—(amp. turns)

(2c)

$$\text{cir. mils} = \frac{I \times N \times K \times L}{12 \times E}$$

(circular mils)

But, for soft-drawn copper wire operating at about 130° F., K becomes (see Fig. 2), 12 ohms. Therefore, where a winding will operate at about 130° F., which is a fair average operating temperature:— cir. mils=I x N x L 12 ÷ 12 x 12. The two 12s cancel out giving as the working formula:—

(2d)

$$\text{cir. mils} = \frac{I \times N \times K \times L}{E}$$

(circular mils)

As outlined in the preceding paragraph, the formulas there given for determining the size wire necessary to produce a certain number of amp. turns are based on the assumption that the winding will operate at a temperature of about 130° F. If the winding actually operates at a lower temperature, the wire size obtained by using the formula in the paragraph just preceding will be larger than necessary. This is because the resistance of copper decreases as its temperature decreases; the graph of Fig. 2, shows how the resistance of a cir. mil-foot of copper varies with the temperature. By substituting the proper value for K. from Fig 2, in the formula given in the preceding paragraph, the amp. turns necessary with any other operating temperature than 130 degrees F. can be easily determined. If the wire for a winding determined in accordance with the formula of the preceding paragraph actually operates at a temperature greater than 130 degress F.. the wire will then be too small rather than too large.

The amount of heat that can be dissipated by a magnet coil without an excessive temperature rise is determined largely by the amount of surface that the coil exposes to the air. It is frequently the practice to assume that there should be the equivalent of 1 sq. in. coil surface exposed to the air for every 0.8 watt of I^2R loss or heat developed by the coil. Experience shows this rule to be safe under ordinary conditions and where it is followed a coil will not acquire a temperature great enough to injure its insulation. A safer practice is to allow 1 sq. in. equivalent for every 0.5 watt of I^2R loss in the coil. It is usually assumed that the heat dissipated through surfaces of the magnet structure, in addition to that dissipated directly from the surface of the coil, amount to from 50 to 75 per cent. of that radiated directly from the coil surface. As a general proposition, no coil that is to carry relatively-heavy currents should be thicker than 2 in.

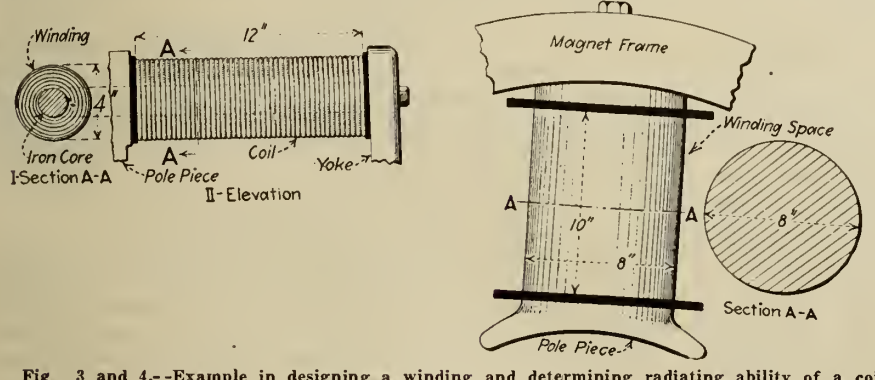


Fig 3 and 4.--Example in designing a winding and determining radiating ability of a coil.

Example

How many watts heat loss can the coil of Fig. 3 dissipate without becoming excessively hot? **Solution.**—Coil is 4 in. in diameter, hence is :—4 x 3.14=12.6 in. in circumference. It is 12 in. long. Therefore, the surface of the coil exposed to the air is:—12.6 x 12=151 sq. in. It will be assumed that the heat conducted into and radiated from the yoke and pole piece will be 75 per cent. of that radiated direct. Then, the total equivalent radiating surface=175 x 151 sq. in. = 250 sq. in. Assuming each sq. in. surface will radiate 0.8 watt, the total watts that can be dissipated by the coil will be 0.8 x 270=216 watts.

The maximum permissible thickness of magnet coils, of cotton-covered wire, that are wound solid—without ventilating ducts—and that may carry continuously relatively heavy currents, is 2 in. Where coils are thicker than this, the heat developed in the inner turns travels slowly to the surface from which it may be radiated. The consequence is, that the inner turns of such coils may become excessively hot. Where the wire comprising the winding is insulated with a non-combustible or heat-resisting material windings may be much thicker than 2 in.

Example illustrating the design of a constant-voltage magnet coil to produce a certain number of amp. turns is given in the following paragraphs.

Example.—Design a winding to produce 11,000 amp. turns for the winding space of Fig. 4. Assume the voltage available to be 110.

Determining Wire Size

(1) Assume that the coil will be 2 in. thick, the maximum permissible thickness (see paragraph just preceding). The magnet core is 8 in. in diameter. Hence, the diameter of mean turn is 10 in. The circumference of mean turn equals:— 10 x 3.14=31.4 in. Substituting these values in (2d):—

(a)

$$\text{cir. mils} = \frac{IN \times L}{E} = \frac{11{,}000 \times 31.4}{110} =$$

3140 cir. mils.

Hence, to produce 11,000 amp. turns under the conditions outlined a 3140 cir. mil winding should be used. Referring to a wire table, a 3140 cir. mil conductor lies between Nos. 15 and 16, American Wire Gage. We will use the larger wire, No. 15. Remember that a 3140 cir. mil conductor will then, produce 11,000 amp. turns, regardless of how few or how many turns of this conductor are wound into the coil.

Ascertain Just How Many Amp. Turns the Wire Found as Above Will Produce

Since with a given voltage, wire-size and mean length of turn, the amount of this No. 15 wire wound on the coil will not affect the number of amp. turns developed, we will find the number of amp. turns developed by 1 lb. of wire. Then the amp. turns developed by a greater or lesser amount of the wire will be the same number.

The length of a mean turn is 31.4 in., is:— 31.4÷12=2.62 ft. From a wire table, 1 lb. of No. 15 wire contains 101.-63 ft. Then 1 lb. of No. 15 would provide:— 101.63÷2.62=38.8 turns. A coil containing 1 lb. of No. 15 would have a resistance of 0.32 ohms. Then a 1 lb. coil would, on 110 volts. pass 110÷0.32 =344 amp. Therefore, the amp. turns of No. 15 wire for the conditions of this ex-

(Continued on page 37)

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Power Plant Costing

A CORRESPONDENT in another part of this issue has a question relative to the comparative cost of pumping water or buying water from the city, and this opens up a question which is very frequently met with in small power plants. It is questions of this kind and the ability to deal with them that stamps a man as being more than the ordinary operating man, and gives him a chance to become an executive in a large plant. In central stations and large factories, where the cost of power is very closely watched, it is absolutely necessary that the chief engineer or the superintendent of light, heat and power as he is sometimes designated, should be familiar with the methods of obtaining the cost per 1,000 lbs. of steam to his department, and the cost of horse power delivered at his engine room switchboard. In some factories each department is treated as being a separate industry, and is charged for its light, heat and power by the engine room or power department, just as though the latter were a central station and the particular department were a consumer. All repairs to steam piping, electrical apparatus, etc. in that department, are charged up by the power department with the actual time, material and a certain charge for overhead which is based on the overhead charges of the power plant. The overhead charges of the power plant will be the interest on the investment, depreciation, and the sinking fund necessary to replace the entire equipment in a certain number of years. These charges are what are known as the fixed charges. The amount that the department is charged for light, heat and power will be based on the consumption of these three items as nearly as can be determined, and the cost per 1,000 lbs. of steam to the power plant, plus a percentage of the fixed charges already mentioned. The power plant is charged up by the costing department with the cost of coal, oil, repairs, maintenance and overhead, and this cost has to be balanced by the cost to the departments. Now, the foremen of the departments are charged with the cost of the material they perform the operations on, and credited with their value as they leave their department, which is of course the value of the operations performed, and a certain figure to cover the overhead of the department.

Now, if a department shows a high cost for light, heat and power against a low production, or in other words operates at a loss, someone has got to explain. The foreman will naturally try to show that his charges from the power plant are too high, and the chief engineer has got to show that he is producing power at the minimum cost. If he can go thoroughly into these figures himself he knows where he stands, but if he is compelled to except the word of the cost accountant he is liable to get the worst of it.

There is another feature of power costs which is very unfair to the engineer. In some plants total production of material is compared against cost of power, or consumption of coal, and the chief engineer is suddenly called upon to explain how it is that the factory production has dropped 15 per cent, while the coal consumption has remained normal or increased, thus giving a much higher consumption per unit of production. Now what happens frequently is this. A large amount of goods which have had practically all the operations performed on them, have to be scrapped when they reach the final stage. They have had just as much power expended on them, or have required the same consumption of coal as if they had been completed. If the engineer has his finger on his costs he can trace this cause to its source, but if he has not, it may take the executive some little time to discover that there was so much scrap that week, and when he does, it is very doubtful whether he will call for the engineer and explain his mistake.

We do not for a minute pretend that every engineer can be a competent cost accountant, but we do think that every engineer should make it his business to look into this question of power costs to the best of his ability, as such knowledge cannot help but be useful to him, if only for purposes of self protection.

Boilers Still Explode

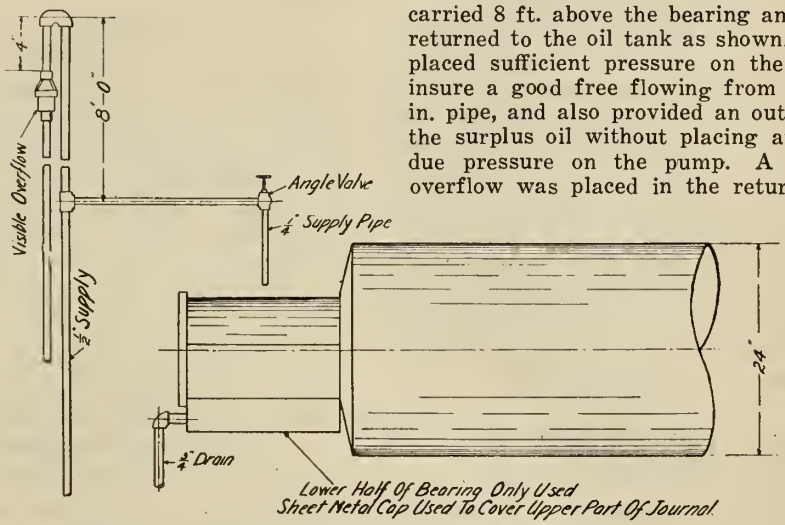
IT IS a remarkable fact that notwithstanding the enormous amount of educational literature and demonstration that has been accorded the steam boiler, that there are still large numbers of accidents yearly happening to these steam generators. We do not hear much about them in Canada, and there are not any statistics easily available, but we do hear occasionally of disastrous explosions. In the United States it seems to be a much more frequent occurrence for a boiler to explode. Of course, there is a vastly greater number of boilers in use in the United States than in Canada, and evidently there is need for a much larger number of inspectors. Glancing over the records of one insurance company alone that issues a statement of explosions coming within its knowledge, we find that for the three months ending March 31st of this year, there were no fewer than 136 accidents, in a little less than ninety days. Of these, no less than thirty were actual explosions, and of these explosions, by far the larger number was heating boilers, working at low pressure presumably. A large percentage of the accidents outside of explosions was due to cracked sections of heating boilers. These figures should go some way to exploding the fallacy that still exists among a large number of people, that because a boiler is operating under low pressure it has but little potentiality for damage. As we have so often pointed out, the damage can be caused as a function, not of the steam pressure, but of the quantity of water above, atmospheric pressure and temperature that is contained in the boiler, and which in turn contains an enormous amount of energy which is liberated when a rupture of the boiler occurs. A heating boiler requires as much care as any other kind of boiler, and this fact should be impressed carefully on the minds of boiler owners and operators till it is universally known and accepted.

The Operators' Point of View

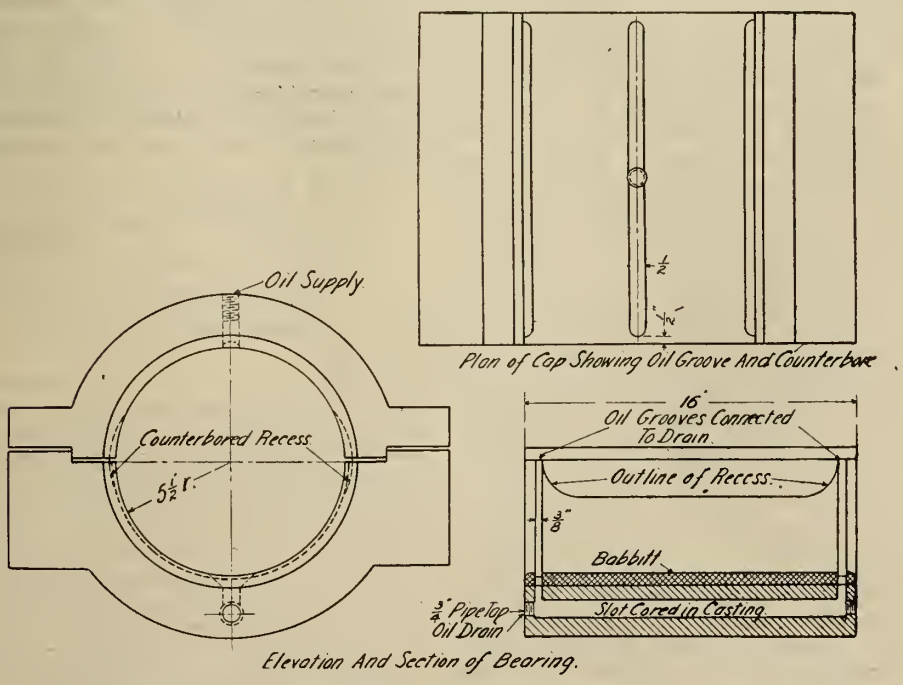
SIMPLE METHOD OF LUBRICATING BEARINGS

After experimenting with various types of bearings, the one which I have shown in the sketches accompanying this article proved most successful. This bearing had to endure a dead load of approximately 150 lbs. per sq. in. projected area and a rubbing velocity of about 6 ft. per min. The bearing was also subjected to considerable heat and had to run hot under the best of conditions. The oil ring type of bearing did not prove at all successful as the oil film was continually breaking down to the slow rubbing speed and the comparative high unit pressure for that speed. The result was a metal to metal contact most of the time as the rings running at such a slow speed could not bring up enough oil to renew the film in the bearing.

A plain babitted water cooled bearing was next tried and, although giving better results as regards wear on the bearing surfaces, it was very wasteful of oil and required considerable attention. The type of bearing shown in the sketch was then designed and proved very successful. It consisted of a plain babbitted bearing with two oil grooves, and a positive, continuous, adjustable oil supply system. The oil reservoir consisted of a tank of about 30 gallons capacity placed far enough below the bearing to allow the oil to drain back into it from the bearing by gravity. A small rotary pump was placed in the oil tank and driven by a chain from a convenient shaft at about 125 R.P.M. A ½ in. supply pipe was used and reduced to ¼ in. over the bearing. This ¼ in. pipe was equipped with an angle valve so that the flow of oil in the bearing could be regulated. The supply pipe was carried 8 ft. above the bearing and then returned to the oil tank as shown. This placed sufficient pressure on the oil to insure a good free flowing from the ¼ in. pipe, and also provided an outlet for the surplus oil without placing any undue pressure on the pump. A visible overflow was placed in the return pipe about 4 in. from the upper extremity. This served as an indicator to see if the oil was flowing freely and prevented the oil being siphoned out of the supply pipe thus leaving the bearing without oil. As the load on the bearing was constant and always in the same direction, the upper part of the box was not used and the exposed journal was covered by a special sheet metal cap to keep dust and grit from the oil and rubbing surfaces. The design of the cap intended to have been used is shown in the detail sketch of the complete bearing. The temperature of the oil used in this system rose to about 40 to 50 degrees above the room temperature and remained fairly constant within these limits. A good quality free flowing light machine oil was used and the temperature rise was not sufficient to cause a break down of the oil film due to decreased viscosity resulting from the increase in temperature.



Sketch is self-explanatory. Shows how bearing is lubricated.



Elevation and section of bearing used.

The oil grooving in the bearing was so designed that the oil would be introduced at a point where the forces acting tend to separate the shaft and the box. At this point a groove was cut in the surface of the box so as to distribute the lubricant evenly over the entire surface of the journal. Having been so introduced it was expected that the oil would adhere to the journal and be carried around to the point where it is pressed against the box with the greatest force, thus forming the lubricating film which separates the rubbing surfaces. As few oil grooves as possible were cut. One at the top of the cap to distribute the oil

over the bearing, and one on each side of the lower half of the box to collect the oil, which would otherwise run out of the ends of the bearing, and cause it to flow by gravity into the lower part of the bearing where the oil grooves are connected to the hole in the box and from which it is conducted by a ¾ in. pipe back to the supply tank where it is strained and used over and over again. In order not to have the oil wiped off the journal before it reached the point for which it was intended, the sharp edges of the box were recessed or counterbored as shown in the sketch.

The upper extremity of this counterbore was connected with the oil grooves at the side so that any surplus of oil would flow into these grooves and back to the tank. The oiling system and bearing just described is simple in construction. The oiling is positive in action and can only fail from the pump breaking down or wearing out and a spare pump should always be kept on hand to meet such an emergency. The bearing has given much better service than those of a more complicated type.

Editor's Note—Who wrote this article? We have by some means or other lost the author's name and address.

BACK PRESSURE HEATING

The Editor "Power House,"

Since "Power House" invited friendly discussion on engineering problems I am taking this opportunity to ask a few questions concerning the article recently published on "The Economy of Working with Back Pressure."

This subject is an important one in paper mills since it is essential that a heat balance be obtained in utilizing the exhaust steam from engines for the various heating and evaporating purposes. Some engines work at a back pressure of only 16 or 17 lbs. absolute while others, which supply steam to the paper machine, operate against pressures of 35 and 40 lbs. absolute.

Taking the example first given in the article referred to steam is supplied to the engine at 100 lbs. gauge or 115 lbs. absolute. Each pound of steam, if dry, will contain about 1188 B.T.U. Now, assuming adiabatic expansion with release at 25 lbs. and a back pressure of 16 lbs. absolute, I figure that the work done in B.T.U.'s per pound of steam to be 143 approximately. The heat absorbed in the cylinder, will even be greater than this when the effect of radiation and other losses are taken into account. Considering these points, are we justified in simply subtracting the total heat of the exhaust as given in the steam table from the total heat of the entering steam in order to get the number of B.T.U.'s absorbed by the engine? If we were using this exhaust steam in the second effect of an evaporator or in a feed water heater, would we be safe in arranging our steam supply on the basis that the exhaust steam still contains 1152 B.T.U.'s per pound instead of the 1045 B.T.U.'s as I have figured it? I ask these questions because the quantities of heat become important items when large volumes of steam are being used.

Taking the other example where there is an initial pressure of 140 lbs. release 55 lbs. and back pressure 35 lbs. with steam initially dry I have calculated the heat converted into work to be about 98 B.T.U.'s per lb. This leaves 1094 B.T.U.'s as available for heating purposes.

I would be pleased to find further discussions on this important subject in "Power House" and to know how others work out their problems in heat distribution.

Yours truly
J. S. Wilson.

In the article the heat losses due to radiation were not calculated, and in an article of that nature could not well be. The idea was to show the general principle underlying the use of back pressure steam. Another article dealing with turbine building for heating purposes appears in this issue. Mr. Wilson's letter opens the way for discussion, and opinions from other readers will be welcomed.

Editor

EFFECT OF EXCESS AIR ON EXIT GAS TEMPERATURE

"The fourth loss (loss due to heat carried away in dry chimney gases) is more truly a combustion loss, though since it is affected by exit gas temperatures this too is dependent on boiler design. Obviously, with a given fuel, and for a given exit gas temperature, the greater the gas weight, i.e, the greater the excess air, the greater the loss of heat in the chimney gases. This loss is kept at a minimum when complete combustion is made to approach perfect combustion.

It will be noted from the foregoing that the two main factors upon which the extent of all combustion losses depend are the amount of air supplied for combustion and the temperature of the gases leaving the boiler surfaces.

The factor of air supply can, within limits, be controlled, but if we assume the ability of a boiler to absorb heat efficiently, the factor of exit gas temperature can only be controlled to the extent that it is dependent on an air supply. In view of this fact the effect of air supply on exit gas temperature must be considered.

On first thought it would appear that since large quantities of excess air introduced into the furnace would reduce the temperature of the products of combustion before the boiler heating surfaces are encountered, such dilution would result in lower exit gas temperatures, and it is of course entirely possible to carry this dilution of the products of combustion in the furnace to a point where such a decrease in ultimate temperature would result. In practice, however, even where the amounts of excess air correspond to the most inefficient combustion, this excess instead of decreasing, tends to increase the exit gas temperature. The common explanation of this apparent phenomenon is that the excess air in passing through and mingling with the actual products of combustion absorb heat from such products more readily than will the boiler heating surfaces, and a considerable portion of the heat so absorbed is carried off in the escaping gases. Such a statement offers by far the simplest explanation, and one which accounts for a part at least of the increase of exit gas temperature with an increase of excess air. The other factor leading to such a result is dependent on heat transfer rates, difference in temperature between the gases and the absorbing surface the percentage of total heat absorbed through radiation and the percentage of total absorption through connection." The above is an extract from "Principles of Combustion in the Steam Boiler Furnace," by Arthur D. Pratt, and published by the Babcock and Wilcox, Co.

"The common explanation etc.," given by Mr. Pratt does not appear to me to be the correct one. This explanation will account for heat loss through excess air, because if two volumes of air beat the same temperature but one volume be twice as great as the other the greater volume will contain twice as much heat as the smaller volume. This shows us that the exist gas temperature alone will not show the heat lost up the stack. In my opinion "the other factor leading to such a result is dependent upon heat transfer rates etc." is the true explanation even if it does lead to a complication of theories as claimed by Mr. Pratt. It is easily understood that when an extra furnace is added to a boiler as is sometimes done in the case of some water tube types when the demand for more capacity is very urgent that the exit gas temperature will unavoidably be higher although the furnace temperature may not be higher. That the increased volume of furnace gases is the cause of the increased exit gas temperature is also easily understod. If the volume of the furnace gases is increased the heat absorbing surface should also be proportionately increased otherwise we may expect higher exit gas temperature.

R. McLaren,
160 Dovercourt Road,
Toronto.

A CHALLENGE

Editor Power House
Dear Sir—

In "Power House" of Oct. 30, a correspondent bewails the fact that so few Canadian Engineers write to their engineering magazines. I will merely relate an incident and then listen for the answer. About 18 months ago Henry Wright of Montreal explained a tube failure in one of a battery of water tube boilers. During the mixup water went over and gave a turbine a hard run for a while but as there was nothing stronger than 2½% in it, which is strange for Montreal, there was no damage done in that quarter although there was at

least one fatality in the boiler room. Mr. Wright asked the opinion of engineers as to the source of the water (which boiler) and as far as I know I was the only one to hazard a guess. Your correspondent so far has not risked his reputation by expressing an opinion. Neither has Mr. Wright told the world whether my guess was right or otherwise, and I would like to know. Now, Engineers, we are listening.

R. McLaren,
160 Dovercourt Road,
Toronto.

TORONTO NO. 1, C.A.S.E.

The regular meeting of Toronto No. 1 Lodge C.A.S.E. was held at Cumberland Hall on Nov. 15th. The regular business of the Lodge being disposed of by nine o'clock, the meeting was handed over to the educational committee, who were easily able to keep the audience interested.

The question box received the first attention, and the answering of the questions found brought out some interesting discussions. Mr. Geo. J. Soucy then gave a very interesting talk on internal combustion engines, tracing the subject from the earliest records to the present day. He illustrated his talk by a number of charts and diagrams, leading up to the development of the double piston two cycle engine, such as is being made in various forms at the present day. He showed the possibility of its application to the automobile field, and its application to marine uses in Great Britain where a number of engines of 3000 h.p. have been built on this principle. The meeting was well attended, and the members expressed much satisfaction with the programme.

WOODSTOCK C.A.S.E. LODGE

Woodstock Lodge, No. 37, C.A.S.E. held a very interesting and successful meeting on the evening of Nov. 14th. The lantern was used for the first time, and Brother Arnup showed a number of different types of boilers on the screen, at the same time explaining the various points of each. The attendance was good, and those present were unanimous in hoping for a continuation of these meetings during the winter.

CATALOGUE

Atlas, Ideal and Victor Reducing Valves, Pump Governors, Pressure Regulators, Hot Water Tank Regulators, Control Valves and Damper Regulators are described in Junior Catalogue No. 21 just published by the Atlas Valve Company, 282 South Street, Newark, N. J. This little catalogue of 20 pages gives complete information—illustrates, describes, lists all sizes and gives prices. A copy will be sent free on request to any reader of this publication.

HOW TO CALCULATE MAGNET WINDINGS

(Continued from page 33)

ample are:—344 amp. x 38.8 turns= 13,350 amp. turns.

Whether 1,10,100 or 1000 turns of No. 15 wire were wound on the core of Fig. 4 (with a mean diameter of turn of 10 in. and an applied voltage og 110) the amp. turns would remain at 13,350.

Determine Heat Radiating From Surface of Coil

The outside diameter of the coil will be 12 in. Therefore, its circumference will be:—12 in. x 3.14=37.7 in. The exposed area of the coil will be:—37.7 in. x 10 in.=377 sq. in. Assume that the pole piece and frame provide a radiating surface 75 per cent. as great as that of the winding. Then, the total, equivalent radiating surface is:—377 x 1.75=660 sq. in.

Determine Watt Power Loss Permissible in the Coil

(4) Assume that each sq. in. of equivalent coil surface will radiate the heat produced by 0.5 watt. Then the coil can effectively radiate the heat due to:— 0.5 x 660=330 watts.

Determine Permissible Current in Coil

(5) With a pressure of 110 volts, the current that will develop 330 watts is:— $I=P\div E=330$ watts $\div$ 110 volts=3 amp. Therefore the permissible current in the coil is 3 amp.

Determine Amount of Wire Required

(6) Through a coil of 1 lb. of No. 15 wire (as calculated in (2), 344 amp. will flow. As determined in (5), the permissible current through the coil of this example is 3 amp. To pass a current of 3 amp., a coil of No. 15 wire weighing:— $344\div 3=115$ lb. would be required. We will then use 115 lb. of No. 15 if it will fit in the winding space available. Since there are 101.6 ft. in 1 lb. of No. 15 bare copper wire, the length of wire in the 115 lb. coil required in this problem would be:—115 x 101.6=11,700 ft.

Check Wire Size to Ascertain if it Can be Wound in Space Available

(7) We must find room for 11,700 ft. of No. 15 wire which must be insulated. The thickness of the coil is 2 in. and its length is 10 in. The cross section of the coil is, then:—2 x 10=20 sq. in. Assume that single, cotton-covered magnet wire will be used. From a magnet table, 1 sq. in. will contain 249 such wires or turns. The 20 sq. in. will contain:—20 x 249 = 4,980 turns. The mean turn has as determined in (2), a length of 2.62 ft. Then, total length of wire that can be wound in coil is 2.62 x 4980 = 12,050 ft. It is, then, evident that there is ample room for the 11,700 ft. that is necessary, as calculated in (6).

Magnet coils operating on constant current, such as coils, of constant-current or series generators and series street lighting system magnets, always have practically the same current flowing through them. Therefore, with such coils the wire size merely determines the I^2 x R loss or heating in the coil. Where such a coil is to be designed, divide the amp. turns required by the amp. flowing in the constant-current circuit; the result will be the number of turns required. Use a size wire that will carry this current without excessive heating.

PECULIAR REPAIR JOB

A job which has been bothering expert engineers for some weeks past is the repair of the Bascule bridge over the St. Mary's American ship canal, and said to be the largest bridge of its kind in the world. Early in October, gusset plates were found torn in the bridge with the counter weight at the southern end of the jackknife displaced. One support beam was broken and another badly twisted, and C. P. R. connections across the bridge were held up for over a week, while 100 men were rushed from Chicago to effect repairs. Traffic has been resumed, but the southern span has to be kept stationary, and cannot be raised. The cause of the trouble originally is believed to have either been from a flaw in the material in the gusset plates, or from some sudden impact on the bridge. The structure has been in operation since 1914, and by reason of its opening up in the centre, by means of counterweights at either end, with the spans raised perpendicularly, it is known as the "Jackknife bridge." The counterweight at the south end was lowered four inches out of place. It is a cement block 1400 tons in weight and to get it back in place with a limited amount of room for the workmen proved difficult. Over 30 jacks were used, fifteen 100 ton compressed air jacks, ten 50 ton jacks, and five smaller ones were put in service. Over 50 men were employed on the jacks alone.

The annual meeting of the Canadian National Newspapers and Periodicals Association, took place in Toronto on Nov. 10 and 11, and many interesting papers were presented. On Nov. 10, a luncheon was held at the King Edward Hotel, at which many prominent speakers took part including the new Lieut. Govenor General for Ontario. His message to the business and technical papers of the country was especially inspiring. He pointed out that Canada was passing through a very critical period, and that it was up to the editors of the various business, religious, technical and kindred journals to lead, and lead carefully. The power of such periodicals was pointed out, and his Honor concluded by saying that he felt Canada would come through with great success as we had as our backbone a wonderful country in itself.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

INTERNAL COMBUSTION ENGINE

Question:—In a certain write up on automobile motors, the writer had this to say. Supposing we had a motor with 3⅝″ bore and 4½″ stroke and another with 3⅝″ bore and 4″ stroke. This ½″ extra length of stroke would as a matter of fact add 5 or 6 h.p. to the former.

Now an increase in the length of stroke means an increase in the length of crank webs. The angularity of connecting rod would also be reduced and if both engines were running at the same speed the piston velocity of the motor with the longer stroke, would be greater. If both motors had the same piston velocity this would necessarily mean that the motor with the longer stroke would have a lower rotative speed. If this is so, and, with equal piston velocities it would be, just what advantage is claimed for the long stroke motors compared with those of shorter stroke, but with same bore?

Answer:—A motor with a longer stroke and same bore as another motor is able to avail itself of a greater range of expansion, or greater range of temperature, which tends to increase its efficiency. If the M.E.P. is the same in both motors, the I.H.P. will be the same with equal piston speed, but the gas consumption should be less in the long stroke engine. With the same gas charge the M. E. P. should be greater in the longer stroke engine. In the longer stroke engine less heat will be given up to the cooling water, and more utilized in the cylinder.

The angularity of the rod is not affected by the length of stroke, but by the proportion of length of connecting rod to length of stroke.

A MOTOR TROUBLE

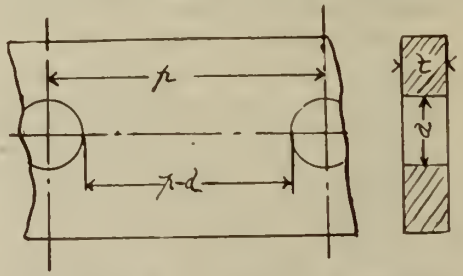
Question:—Could you please answer the following question in your next issue of Power House. We have an oil burning system which is operated by a half horse power motor. This motor is operated and controlled by a 110 volt d.c. rheostat. Recently I left the motor running in good order, and was away some little time, and when I came back found the motor stopped, but with the motor still in circuit, the rheostat being in the same position as when I left. I made close inspection of the whole system, and found everything o.k. excepting the motor was beginning to heat. On releasing the switch the control arm of the motor came back to the off position. The switch was put in, and the motor started up again with the rheostat without any further trouble. What was the cause of the motor stopping?

Answer:—This is rather difficult to say positively. We presume that the motor in question is arranged as a variable speed motor. The source of current is not stated, that is whether it is supplied from an outside agency or is generated on the premises. It is quite possible that the voltage may have dropped in attendant's absence, and the motor was pulled up by not having sufficient torque to overcome the load. There could still be enough current passing through the control to energize the magnet and hold the control arm against the armature in the full open position, or if in a position for slow speed the control arm would remain open anyway. If the motor had remained in this condition very long the winding would probably have burned out or the fuse blown on the main switch. The condition probably only lasted for a very few minutes or perhaps less than a minute before the attendant returned. Some of our readers may be inclined to put forward some theories, which will be welcomed.

CRUSHING STRESS

Question:—Would you please explain in the next issue of your paper what is meant by a crushing strain, and where it takes place in a steam boiler.

Answer:—A crushing stress is really a compressive stress, and may occur at various parts of a boiler, such as combustion chambers of Scotch marine boilers, internally fired furnaces, etc. The term crushing is usually applied however, to the stress on the metal outside of a rivet hole that is extending



from the edge of the hole to the edge of the plate. If you could imagine in the case of the single riveted joint illustrated, that the plates were torn apart, not by the plate tearing between the rivet holes, nor by the shearing of the rivets, but through the metal from the edge of the rivet hole to the edge of the plate being crushed against the rivet, you have the idea of the crushing stress referred to. The strength of the metal to oppose this stress is very high, about 50% greater than the tensile strength, and thus there is little danger of the joint failing in this manner.

COST OF PUMPING

Question:—We find it necessary to elevate water about 55 feet to a tank from where it returns by gravity to various parts of the building, where it is used for various manufacturing purposes. There is sufficient water available from the ammonia condenser, which could be pumped into the tank, but it is argued that it would be cheaper to use city service water. How would the cost of pumping such water be calculated i.e. the cost of pump, not counting cost of connections and connecting up, steam for operation, maintenance repairs and depreciation, spread over a period of five years, and other factors that are necessary of consideration? An example of such a calculation using any convenient quantity of water, would be greatly appreciated.

Answer:—The question of whether it is better to use power or buy city service water, independent of what is required for the ammonia condenser, would seem to be governed by the fact first of all that the city pressure would hardly be sufficient to raise the water to the height required. However, if it is a question of whether if the city water was of sufficient pressure to raise itself the required height, would it be cheaper to put in a power pump or steam pump, and use water already having served one purpose, or purchase a separate supply altogether.

Suppose the quantity required was 1000 gallons per hour. A steam pump for this quantity could be purchased for about $240, and then there would be the cost of maintenance and repairs to consider, as well as the cost of steam to drive it. One thousand gallons raised 55 feet is equal to 550,000 foot lbs. per hour, or roughly 10000 foot lbs. per minute which is about one third of a horse power The probable steam consumption of a pump of this kind would be in the neighborhood of 120 lbs. steam per hp. hour, or in this case about 40 lbs. steam per hour. The cost of steam will vary according to the efficiency of the plant, but we could roughly reckon on 5 lbs. coal per hour, and this for a ten hour day would be 50 lbs., and for twelve months of 300 total working days, 150000 lbs. of coal. If this coal costs $8 per ton the fuel cost would

then be for 1000 gallons per hour about $60 per year. The investment cost would be $15 per year, and the depreciation $24 per year. Repair and maintenance for a pump of this kind would cost at least 10% of the total cost of the pump per annum, or say $24 per year, and might be higher. The total cost would then be about $113 per year. This allows nothing for replacement, and it would be necessary to place a certain sum in reserve each year for this purpose, which should be sufficient to replace the cost of the pump by the time that the depreciation has amounted to the full value of the pump, or in other words, when the pump stands at nothing in the equipment value, a sufficient sum should be on hand to replace it. This would add another $24 per year to the cost, and bring it up to $127 per annum. Different firms have different methods of taking care of depreciation and replacement costs, but this method allows for practically all charges.

Now with city water at 13 3-4 cents per 1000 gallons, and a consumption of 10,000 gallons per day for 300 working days, the cost would be $412.50 per annum. The difference in cost in one year would be enough to pay for the pump and all charges. The cost of pumping would probably be much less if a motor driven centrifugal pump were used, of if a shaft is available, a power driven pump. There is the question also to be considered if it would not be possible to deliver the water direct into the service pipes, without the expense of a tank and connections. In this way, with a suitable governor on the pump, water would only be supplied in sufficient quantities to maintain the pressure on the mains, and there would be no loss through the overflowing of the tank which invariably occurs at different times.

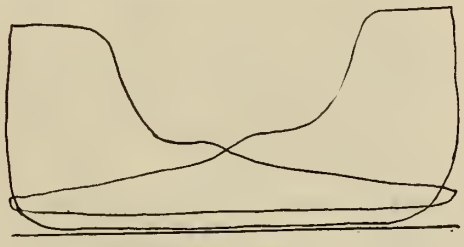
A question of this kind involves a very large number of factors, but it seems to be impracticable to purchase a second supply of water when there is water available that has already been paid for. The question of water supply for a large factory is always an important one, and wherever it is possible to secure water by means of a private well, or location on the banks of the river or lake, considerable savings can be effected.

If larger quantities of water have to be handled, then the cost would be altered in this way. The proportion of investment cost would be lower as the cost of a larger pump is not proportional directly to the size, but decreases with increase in capacity. Thus a pump for 2000 gallons per hour would not cost double that of a pump for 1000 gallons, but probably only one and a half times as much. As the size increases the efficiency of the pump, or the foot lbs. delivered per heat unit consumed becomes greater. Maintenance and repairs remain about the same proportion, and attendance will be the same, the ordinary staff of the engine room being able to take care of a large or small pump without any increase. Extra time spent would of course come under the head of maintenance.

AN INDICATOR CARD QUESTION

Question:—Will you tell me through the columns of Power House what is the matter with this indicator card, whether the trouble is in the engine or the indicator. The card is taken off a Brown engine carrying 130 lbs. initial pressure and running a 120 barrel flour mill.

Answer:—We presume that the fault referred to by our correspondent is the hump that appears in the expansion



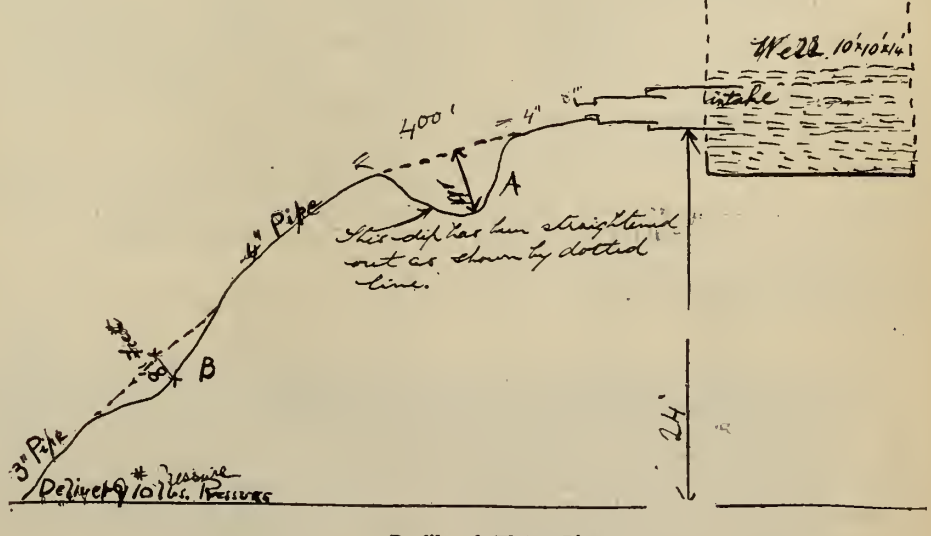
What is wrong?

line on both ends of the cylinder. This would appear to be a defect in the indicator, and is probably caused by the piston of the indicator cylinder. There may be a hard spot caused by oil having carbonized, or perhaps the indicator has been put away wet, and a rough spot has been formed by a little local corrosion. As the hump appears at both ends of the engine cylinder, and at exactly the same height on each card, it would appear to us that it is clearly an instrument fault. Perhaps our readers will not agree with this view, and we shall have some comment. There is another peculiarity of the card, which is not due either to the engine or the indicator, but to the one who traced the card. Our readers will notice this at the first glance.

LOSS OF PRESSURE IN PIPES

Question:—I have been troubled quite a lot lately with a water supply to a power house, through not being able to get a sufficient supply from our own well. We have also had to buy water from the city when our own well still had water in it, but we could not get it to the power house in sufficient quantities. Our well is about two miles from the power house, and has a gravity flow which must have a head of 24 feet, as we get about 10 lbs. pressure at our delivery. The well is 10 ft. sq. and 14 feet deep, intake pipe at well is 10 inches inside, for twenty feet, and is then reduced to 8 inches, again to 4 inches, and finally to three at delivery. The pipe was at one time reduced to 4 inches to 2 inches then came back to 4 inches and again to 2 inches. I took out 500 feet of two inch pipe and put in three inch expecting to get a better flow but got no more out of the 3 inch pipe than I got through the two inch pipe. At one part of the pipe line, pipe took a drop of 11 feet in 400 feet then came back to level again. I took this loop out and ran pipe on gradual grade. Close to the power house the pipe has to raise 8 feet again to suit grade of road, and I don't know if that is all the cause of our shortage or not. Sometimes we get as much as three hundred cubic feet per hour with the same amount of water in the well as at other times when the flow is only two hundred cubic feet per hour. I have tried every way I know to chase the water down but cannot succeed, and am enclosing a rough sketch. When we have a ten inch pipe full at well, we cannot get a three inch pipe full, at delivery. Can we overcome this without the aid of a power pump?

Answer:— Judging from the layout of the pipe as shown in the sketch, it is not surprising that there is difficulty in getting a steady delivery of water. The fact that you get 10 lbs. pressure on the delivery would seem to indicate that the head of water is considerably over 24 feet. In a slope of 12 feet to the mile, the loss of pressure per 1000 feet of length is approximately 1 lb. per sq. in., and as your pipe is over



Profile of Water Pipe.

10,000 feet long, and full of kinks, you would get but little delivery if the water had the head given by you. 300 cubic feet per hour is only .083 cubic feet per sec. which is velocity in feet per sec. of 1.7, or 102 feet per minute.

The piping is too involved to attempt to calculate the flow, but you are getting about the flow you could expect if your piping was 3 inches diameter, and the slope was 24 feet in 10,000. The remedy would seem to be to straighten out the pipe, and provide ample area for the quantity of water you require, under the actual head, which you can obtain from a profile map of the country. Putting in a power pump with the existing piping would simply mean that you will create an artificial head, at the expense of the power necessary, in order to overcome the friction of the piping as it exists. We should imagine that the amount of expense at stake would justify the employment of a surveyor to discover the exact conditions of head, and the possibility of running a pipe with a direct slope to the power house, as free from bends as can possibly be done. From the sketch it would appear as though the 8 foot dip could be straightened out to advantage.

SOME INTERESTING QUESTIONS

Question:—In the case of a pair of slide valve engines 14 by 18 inches running at 210 r.p.m., boiler pressure 140 lbs. per square inch, and cut off at three quarter stroke, what horse power would they deliver at the saw?

Answer:—The horse power delivered at the saw would be the product of the indicated horse power and a factor which would cover mechanical losses in the engine and the transmission apparatus, and would of course vary. The indicated horse power would be four in the usual way, and with cut off at three quarter stroke, the ratio of expansion would be the volume up to cut off divided into the final volume, 4-3, or 1.33 The mean pressure can be obtained by formula

$$Pm = pl \frac{1 + \text{hyp. log } R}{R}$$

which is

$$Pm = 154.7 \frac{1.122}{1.333}$$

in which Pm is the absolute mean pressure and pl is the absolute initial pressure and R the ratio of expansion. The hyperbolic log is the common log × 2.302.

This gives a mean effective pressure by the formula of 115.3 lbs. per square inch. Filling in the other factors in the horse power formula we have

$$\frac{14 \times 14 \times .7854 \times 115.2 \times 1.5 \times 420}{33000} = 368.8$$

Multiplying this by 2 as there are two engines we have a horse power of 737.6. The brake horse power of the engines would probably be .95 of the indicated, which would give 700.7 horse power available at the fly wheel. The power then available at the saw would depend on the efficiency of the transmission

Cards from Sawmill Engine.

from the engine flywheel to the shaft of the saw, and might vary within fairly wide limits, according to the system used.

A card from these engines is here reproduced, but our correspondent has neglected to mention the scale of the spring used, so that we cannot work out the indicated horse power from the diagram. Our correspondent further asks the following question. Would same engine be considered ample to drive a sawmill to cut 140,000 feet of lumber in a 10 hour day? This is a question we cannot answer off hand, as there are such a large number of factors entering into it. Could any of our readers who have had large sawmill experience let us have their views on this question, which is an interesting one?

While still on this subject, the question is put. "Would you consider engines of ample power, if they could be pulled down dead with only bottom saws in log, when both top and bottom saws have to be buried in the log 30% of the working time?" Again the information is hardly sufficient for us to answer it very positively, but on the face of it, we should not. Here is another question that our saw-mill friends should be able to offer information on.

Would engines give better power with two governors 3½ diameter or one 5 inch governor?

Providing the governors are set to work at the same speed, the engines being identical, we do not see as far as the power is concerned that it would make much difference. There is this point, that if the engines are supplied from a common steam pipe, and drive a common fly wheel, it would be preferable to have a single governor controlling admission of steam to both cylinders at the some time and this would give closer regulation.

The last question of the series is as follows. "Which would be the more efficient, a pair of 14 x 18, at 210 R.P.M. or one single 18 x 24 inches at 200 R. P. M.?"

We presume that what is required is the power and not the efficiency particularly. As a question of pure thermal efficency, the single engine would probably show up the best. From a horse power point of view, allowing the same mean effective pressure for both engines, we have for the pair of 14 x 18 with 115 lbs mean pressure 737.6. With the same mean pressure the 18 x 24 inch engine at 200 r.p,m. would give 709.4 indicated horse power. Such an engine would be less in first cost. In a sawmill it is not generally of much importance whether an engine is economical or otherwise in steam consumption, the main thing being to get the power. There is usually more fuel available than can be used, at least, this has been our observation of sawmill practice.

POWER FOR CIRCULAR SAW

Question:—In the case of a circular saw 56 inches diameter having forty teeth, in changing it for one of the same diameter and same width of tooth, speed and condition being the same, but with 46 teeth, which saw will take the most power?

Answer:—Changing the number of teeth on circular saw from 40 to 46 is so slight a change that there will be but little difference in the operation. However it has been proved by experiment that increasing the number of teeth in a saw for the same diameter, or in other words decreasing the pitch of the teeth, causes more power to be required in accomplishing the work of the saw. The reason given is that there being a larger number of teeth in the log at one time, the friction is greater, and although there is less work on each tooth, in the aggregate the power required is greater than with the smaller number of teeth.

BOILER HORSE POWER

Question:—What will be the horse power of a boiler 6 feet diameter by 16 feet long, with 88.3 inch tubes?

Answer:—The rated horse power is 1/15th of the heating surface and the heating surface will be half the circumference by the length of the shell, added to the circumference of the tubes in feet by the length of the tubes and their number.

$$\text{H.S.} = \frac{16 \times 6 \times 3.1416}{2} + \frac{3 \times 3.1416 \times 16 \times 88}{12}$$

$$150.79 + 1105.8 = 1256.59$$

and the horse power will be 84. The actual horse power developed under natural draught may be taken as the fire grate area x 3, which would be 5x5.5x3 =82.5.

ANNOUNCEMENT

The Westinghouse Electric & Manufacturing Company announces the following changes in its Service Department: B. B. Burkett has been appointed District Service Manager in the Seattle Office, succeeding N. P. Wilson, who has been transferred to Sales Service activities in the Seattle territory.

The Salt Lake Service Department has been made a branch of the Denver Office, under the direction of A. F. Maccallum, District Service Manager, Denver. M. R. Davis, formerly District Service Manager at Salt Lake, will remain at Salt Lake and devote his time to field service work and to securing repair business for both shops.

Handling Coal and Ashes in the Modern Power House

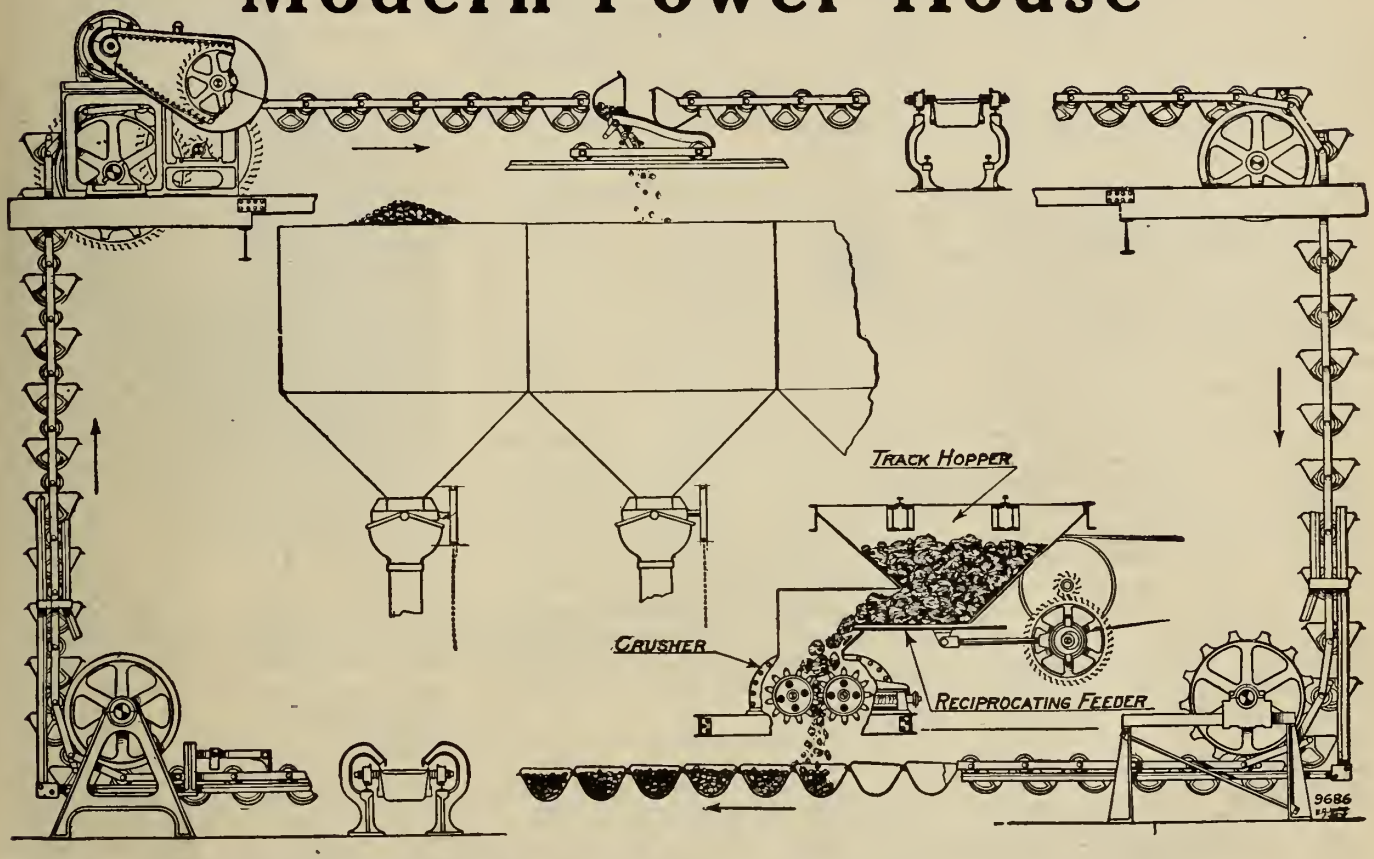


Diagram Showing Operation of the Peck Overlapping Pivoted Bucket Carrier

THE Records of Performance of our Peck Carrier—an overlapping pivoted-bucket machine for handling coal and ashes in power houses—merit the close attention of Engineers and those who contemplate the installation of such equipment.

The Peck Carrier is the recognized standard carrier for coal and ashes in the modern power plant. It has earned an enviable reputation for satisfactory operation and low upkeep costs.

The maintenance charges of the Peck Carrier during the early years are almost negligible. Let us show you some of these records. Send for one of our Engineers.

Also write for Peck Carrier Catalog No. 220

CANADIAN LINK-BELT CO., LIMITED

TORONTO, Wellington and Peter Sts. **MONTREAL, 10 St. Michael's Lane**

Value of Boiler Inspection

We here reproduce an article on the value of boiler inspection, which appeared in the "Locomotive," the journal of the Hartford Steam Boiler Inspection and Insurance Co. After a few preliminary words the article goes on as follows:—

Some years ago a representative of this Company called upon a mill owner in an endeavor to interest him in boiler inspection and insurance, but the owner could see no value in such service. About a month later a crack developed in the longitudinal seam of one of the boilers in this mill and a supposedly experienced mechanic was called in. The crack was drilled at intervals, the holes tapped out, and soft iron plugs inserted to stop the leakage. About a week later the boiler exploded, fatally injuring the fireman and seriously injuring his wife who happened to be there at that time. Had this boiler received the attention of of a qualified inspector the dangerous condition could have been pointed out in time to prevent the disaster which occurred.

Mention was made, in the July issue, of repairs to a lap seam crack by autogenous welding. It has been reported to us that a boiler belonging to the Wishkah Shingle Co., State of Washington, was repaired (?) at a lap seam crack by this method and soon afterwards exploded, killing three people. It was said that the boiler was not regularly inspected by a competent person and that the owners had no knowledge of the danger in such a repair.

Many similar instances are recalled of the inevitable sad results which follow improper treatment of a lap seam crack. This type of failure frequently shows itself by a leak extending over a comparatively short distance. The boiler plate may very likely be cracked over a considerable distance but, not being apparent by casual inspection, this is not realized and repairs are confined to the vicinity of the leak. A soft patch is frequently placed over the leak, sometimes temporarily alleviating the leaky condition and at other times accentuating it. Sooner or later, however, the crack extends through the plate at other points and an explosion frequently results.

But the lap seam crack, although a frequent offender, is not the only cause of trouble. Many conditions, dangerous to life and property, are found on the trips of the boiler inspector. Cracks in other parts of a boiler, such as to make it unsafe to use, have often been found. On one such case, cracks twelve and fourteen inches long were found at the bend of the flange on each side of the fire door sheet of a locomotive type boiler and in addition, some smaller cracks in the side sheets, making it necessary to condemn the boiler as unfit for service. A second hand dealer purchased the boiler and sold it to a sawmill in Virginia. A few days after it was put into service it exploded and two persons were killed. In this case the inspector gave protection to the original owner and also did all he could to safeguard the public by warning the second hand dealer not to sell the boiler but to cut it up for scrap. The unscrupulous dealer, however, was not so mindful of the safety of others. A similar case was that of a boiler which exploded, some years ago, near Clifton Heigh⁺ , Pa.

Repairs, that to the inexperienced appear safe, but to the boiler inspector are immediately recognized as dangerous, are frequently found. In one such case a bag had developed in a boiler from overheating which resulted probably from an accumulation of scale. The "repair" made in this case is illustrated in Fig. 1, below. The center of the bag or bulge was tapped and a ⅞″ threaded rod screwed in with the end upset or riveted over. The upper end was supported by a flat iron bar resting on the top row of tubes. The idea apparently was to prevent a complete failure at the bag. However, an excellent place for scale to accumulate was provided by permitting the bulge to remain and the condition presented was rather dangerous. Our inspector had the rod removed. The plate was then heated and the bag driven back, the small hole being plugged with a rivet.

The corrugated furnace in one of two Scotch-marine boilers collapsed and necessitated repairs to that boiler. Thinking it advisable to investigate conditions in the other boiler, a hydrostatic test was applied by our inspector and the furnace showed a decided tendency to collapse, indicating that the structure was weak for the pressure desired. It was recommended that a new furnace be installed and assurance was given that this would be done. A few weeks later the owners requested that we make an examination and this we proceeded to do. The results were rather remarkable. It was found that the repair man who was called in to do the work, after looking over the boiler, and announcing that he could "fix her as good as new," apparently concluded that a cylindrical furnace, lying in a horizontal position, could only collapse from the upper side although subjected to pressure from all sides. He therefore placed four 1½″ rods extending from the upper surface of the furnace, where the furnace had first shown a tendency to collapse, to the top of the boiler shell and then remarked to the engineer, "There she is, she's all yours." Unfortunately for the owner, this repair could not be approved.

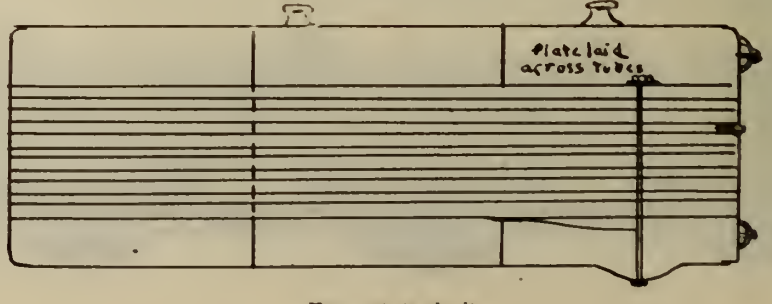
Improper attachment or use of boiler appliances often results in damage to the boiler even if an explosion does not occur. Such conditions are often found and corrected by the boiler inspector. As an example we cite the following:—

One of our inspectors, when calling at the office of a certain plant was advised that considerable trouble had been experienced from leakage at the girth seams of the horizontal water tube boilers in use in the plant. The superintendent stated that they had recaulked the seams a number of times but to no avail and the boiler maker who had done this work had expressed the opinion that they had received a "bum bunch of boilers." On walking into the boiler room the first thing that struck the inspector's eye was that the water glasses were considerably below the drums of the boiler. A comparison of the water level in the gauge glass with the height of the drums showed that the water columns were set 12″ too low so that when the normal water level was carried in the water column there was absolutely no water in the drums. This resulted in rapid overheating as soon as the boiler was fired up. When the water column was correctly placed and the seams again caulked no further trouble was experienced.

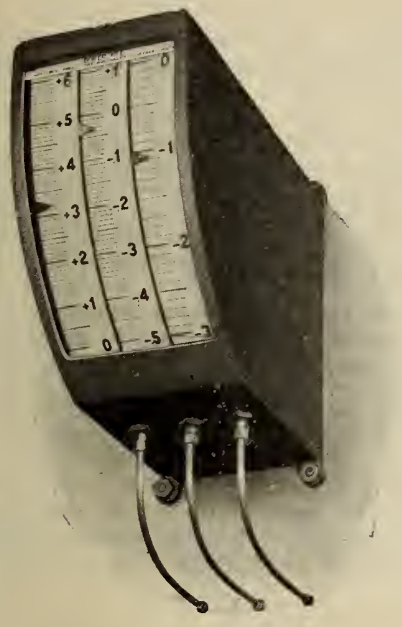
Improper pipe connections are often found. As an example of this condition, the following experience, related by one of our inspectors, will be illustrative.

"As I was going about my regular work I stopped at a small mine and became engaged in conversation with the engineer who claimed he was a licensed man and said that he had installed the boiler plant. He took great pride in showing me the installation but after looking it over I was unable to work up the same degree of enthusiasm that he had and the reason may easily be explained.

"The faulty connection that first struck my eye was that a ½ in. pipe had been run down from the dome of the boiler to supply an injector and a feed pump, both of which required a 1 in. line, and to this pipe the steam pressure gauge had also been attached. The steam pressure, when first noted, was 100 pounds. Soon however, the injector was started and, because of the pressure drop which then took place in the ½ in. pipe, the gauge reading fell back 60 pounds. The engineer noticed this and immediately forced his fire a little harder



How not to do it.



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which soon resulted in the safety valve blowing off although the gauge reading did not rise any great amount. Seeing this, the engineer remarked, "sometimes that safety valve doesn't work just right. I don't know what gets the matter with it. I've had it off several times and examined it but I can't find anything the matter with it."

"I stepped outside to look up at the valve which was about twelve feet above the boiler and while looking at it the blowing stopped. A few minutes later I walked in and looked at the pressure gauge. It showed 140 pounds. I immediately started an investigation to determine the reason for the safety valve remaining closed with this pressure behind it and, when I climbed up on the boiler, I soon discovered the cause. There I found a gate valve, closed tight, in the line leading to the safety valve. Apparently the engineer had closed it when I stepped outside for just then I saw him come around to the front of the boiler, glance at the pressure gauge, and then rush up the ladder to open the gate valve. This I cautioned him to do slowly as a sudden release of the pressure on the boiler might have caused an explosion. As soon as a few turns had been given the gate valve to open it the safety valve began to blow and continued to do so until the pressure was reduced to 100 pounds.

"A sketch of the boiler with its improper pipe connections is given in Fig. 2. In addition to what is shown there I might mention that the blow off line had been piped outside the building where a trap had been formed so that any water accumulating in it would freeze very readily. A man, in blowing down the boiler, would have been placed in a very dangerous position.

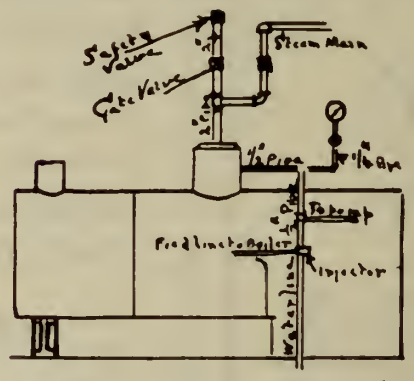
"A short time later I had to make an internal inspection of this same boiler and, although the engineer said that he had just had the boiler open the day before and that I could take his word as to its good condition, I found it to be in very poor shape. Although no great amount of scale was present, a considerable amount of corrosion and a number of cracks in different parts of the boiler were found. When this information was given the superintendent he ordered the boiler out of service."

Inspections are of value not only in the detection of dangerous conditions but also in preventing unnecessary expenditures for repairs. In one case a tube ruptured in a vertical water tube boiler and there was also some slight overheating of several other tubes. The coal mining company who owned the boiler engaged a repairman to put the boiler in serviceable condition. This repairman had them place an order for new tubes which were to cost $1,200. He expected to almost take apart the entire boiler—the total cost to be about $2,500, and had actually started work. Someone, however, suggested to the coal company that they obtain the services of a boiler inspector and at their request we rushed a man over to the plant. As a result of his inspection the repairs necessary were limited to ten new tubes and some other minor repairs, amounting in all to about $250, or a saving to the owner of over $2,000. This was at pre-war prices and the figures would be considerably greater at the present time.

In another somewhat similar instance the expenditure for repairs was reduced from $1,100 to about $20. In still another case a boiler had been condemned, by a steam fitter, as unfit for further use but upon examination by a boiler inspector was found to be good for many years more of service.

The boiler inspector also finds a field of service in the help that can often be given a manufacturer in the arrangement of his steam generating equipment and piping. In a certain plant where rendering tanks were used, considerable difficulty had been experienced in obtaining a lard of uniform quality. Changes that were recommended by the inspector resulted in safer working conditions and a more uniform product.

In another striking instance. which seems almost incredible but which, nevertheless, is true, a furniture factory complained of the wastefulness of their boiler equipment from the standpoint of fuel consumption. After an inspection we recommended the installation of a boiler of a different type. Before the change the plant used a car of coal a month in addition to the refuse from the mill.



Faulty Connections on Boiler.

After the change the coal consumption was reduced to a maximum of two cars of coal per year. It does not require much figuring to compute the saving that would be made in a case like this.

Many accounts might be given of the savings resulting from the suggestions of the boiler inspector, such as the covering of steam pipes, use of pumps and exhaust steam heaters in place of injectors, use of a lesser number of boilers to carry the load, and so forth. We shall content ourselves, however, with the relation of one instance which is interesting from more than one point of view.

One of our inspectors, upon visiting a plant, noticed that the exhaust steam drips were being discharged to the sewer. He made the recommendation that this practice be discontinued and, with the proper piping arrangements, the condensate be returned to the boiler so that whatever heat was contained therein might be saved. The next visit of inspection was made by a different man and the engineer of the plant, in speaking to him of the recommendations made by the previous inspector, said, "Now wasn't he a numskull? Why we had already cooked all the steam out of that water."

It would be practically impossible for the owner of a plant to give the time for a personal inspection of his boilers even though he were so inclined and sufficiently experienced in this line of work. No matter how efficient operating engineers may be in running their plant, but few of them have specialized training to qualify them as inspectors of boilers. On the other hand the expert boiler inspector examines the boilers for all known causes of trouble and then the owner is handed an unbiased statement of the condition of the equipment. If everything is in good shape the owner has a sense of security from accident, or, if there is trouble in sight, ample time is given to make repairs before the danger point is reached.

ELECTRICAL PLANT

A new electric power development will be erected at Great Falls on the Winnipeg river, 63 miles from Winnipeg. It will have a capacity of 168,000 horsepower and will cost about $10,000,000. Announcement of the successful result of financial negotiations was made recently by A. W. McLimont, vice-president of the Winnipeg Electric Railway Company. Work on construction already is under way, with about 200 men employed, but as the work develops between 1,000 and 2,500 men will be engaged.

The undertaking will be carried out under the charter of the Manitoba Power Company, which company is taking over the plant and assets of the Winnipeg River Power Company. Sir Augustus Nanton is president of the Manitoba Power Company, and Mr. McLimont is vice-president in charge of construction and operation. The plant will be constructed in six units of 28,000 horsepower each, and work will be completed in 1924. Promotors of the development believe that the availability of a large quantity of cheap power will do much for Winnipeg's industrial promotion.

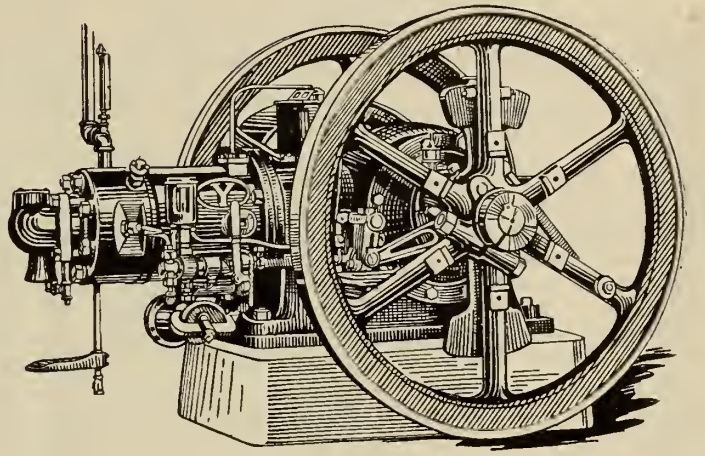
NEW ANTI-FRICTION METAL

There are many special alloys for the purpose of lining the bearings of machinery so as to reduce the friction to a minimum. The objection to most of these is that if from any cause they should become hot the metal melts and runs out. This drawback is avoided in a new metal which has been tested in Great Britain with very satisfactory results. In these tests the metal became very hot without showing any signs of melting, and when forced lubrication was used the bearings showed no sign of wear or flow even with a load of over 1,000 lbs. per square inch.

Reliable power at low cost

Fairbanks-Morse Type "Y" Semi-Diesel Engines are designed to operate on low grade Oil. Some of the special features of this engine are:

Power at minimum cost—Operation practically automatic — Perfect lubrication — Combustion Chamber water jacketed—No hot ball to overheat or burn out—Air tight crank case—Special quick starting arrangement.



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There is a host of ways to arrive at the much desired result, of course.

One of them—a tremendous help in reducing boiler-room losses—is the Vulcan Soot Cleaner. It reduces stack temperature, increases steam capacity and production, and decreases fuel consumption.

Send for a Vulcan Bulletin and let it show you how and why Vulcan Soot Cleaners are a vital necessity in the modern boiler-room.

The VULCAN SOOT CLEANER COMPANY

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The Bulletin shown describes the Vulcan Soot Cleaner for Stirling boilers. Other Bulletins are: No. 541, for B. & W. boilers; No. 547, Wickes; No. 550, Connelly, Badenhausen and Erie City Vertical; No. 552, Edge Moor; No. 556, Keeler, Geary and Union; No. 534, Return Tubular.
Ask for the one for YOUR boilers.

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PUMPING STATION FOR MONTREAL WILL BE MODERN IN EVERY RESPECT

MONTREAL is growing. In fact is growing so rapidly that its present water supply service has to be increased again. As the city has grown, additions to the water supply have been made, but during the last year the water consumption increased two million gallons per day. The capacity of the Point St. Charles low level pumping station has been increased several times, but the later additions include electric driven turbine pumps. In the old pumping station are three of these units. There are two units each of thirty million gallons per day capacity, and one of twenty millions. One of the larger is a De Laval pump, and the other a Worthington. Both are driven by Westinghouse motors. The smaller pump is a Mather and Platt, driven by a Canadian General Electric motor.

Together these pumps have a daily capacity of eighty million gallons. During the hours of peak load however, they cannot take care of the city's requirements, and steam units are thus daily called into service. After due consideration it was decided to build a new pumping station as the old one had been enlarged to a point where it was neither practical nor advisable to go farther.

The new station is located a short distance from the old station, and very close to the filtration plant. The water is taken from the St. Lawrence River at a point some distance up the river and is conveyed to the pumping station by means of an aqueduct. Almost twenty-five feet of lead is obtained and some three thousand horse power can be developed, if desired, from the water passing through the aqueduct without increasing the velocity beyond that which is necessary to carry away any sediment and thus prevent the gradual filling up of the aqueduct. The present lining of the banks is designed for water supply only and not for power purposes. At present all water passes through the filtration plant and experiments have been conducted, the results of which, lead the engineers of the Montreal Water Board to believe that the capacity of the filtration plant can be so increased that the requirements of the city can be taken care of for several years to come.

The new station is to be the best equipped and most elaborate of its kind in Canada and one of the most complete on the continent. It will have a capacity of three hundred million gallons per day, divided in two similar wings, each having a capacity of one hundred and fifty million gallons per day and situated symmetrically about a central control portion of the building. It is only proposed to build one wing and the central control section of the building at this time. The wing will contain six pumping units of thirty million gallons capacity a day. As one unit will be always held ready as a spare the nominal capacity will thus be one hundred and fifty million gallons per day.

The building will contain its own machine shop, the executive offices of the Montreal Water Board, and one section will contain the transformers, oil switches, etc. The feature however, is the central control. One man will be able to operate and control every unit in the station. Besides, the operator will be so advantageously located that he can see every part of the room where the motors and pumps are located. In addition a very complete signalling system is installed, similar to the marine telegraph used by ship's officers on the bridge of a vessel to communicate with the staff in the engine room. The feature of this, is that every order is confirmed by the man receiving it before it is executed.

Rarely has it been the privilege of the writer to see an installation where greater care and thought have been exercised to prevent a breakdown from either electrical or mechanical failures. The electricity is received from the power company in two towers each quite separate from the other and both distinctly apart from the pumping station building. Here lightning arrestors and other protective apparatus are found. Several separate underground lines lead from the towers to the transformers. All equipment is of generous proportions and amply protected. Throughout, duplicate installations of leads, switches, etc., are found, and where there is any chance of even a temporary tie up, triplicate and quadruplicate installations are made. No risk from hot contacts in switches are taken. All equipment is spaced well apart so that a "short" or fire in one piece of equipment will not in any way jeopardize another. Mr. Chas. Des Baillets of the Montreal Water Board had charge of the design of the building, and the selection of equipment. Great credit is due him for the precautionary measures he has taken to prevent a breakdown in the equipment.

Each pump discharges at 95 pounds pressure into a 36 inch pipe, thence through a Venturi meter into a large 72 inch main. The contract for the building was recently let to the Atlas Construction Company of Montreal. Work is being started immediately and will be rushed to completion. The first pump will be operating in the new station in September 1922. Power is taken from the Montreal Light, Heat and Power Company which Company has transmission lines from Shawinigan Falls, Cedars Rapids, Soulanges, Chambly, and Lachine, all hydro electric power, and also from the steam driven plant at Ville La Salle.

OIL TESTING SERVICE

The Westinghouse Electric & Manufacturing Company has established an oil testing service wherein operators can mail samples of insulating oil to the Westinghouse works for test. It provides a thoroughly dry bottle, a safe mailing container, which when received at the works allows careful testing by experienced men and a prompt report of test results. This fills the needs of many power plant operators who have no good method of telling whether or not their transformer oil is in perfect condition.

Considerable thought has been given to the development of this service, with the idea of making it simple for the operator to handle and give him a prompt report as to the condition of the oil. After drawing the sample the operator seals, packs and mails the bottle to the Engineering laboratory at East Pittsburgh. To make this part of the work easy, an instruction and order sheet and a printed return label have been provided. The instructions cover the taking of the sample and its proper preparation for mailing. The label carries an envelope in which the operator can enclose his order covering the work of testing. As soon as the test is made, a report of the condition of the oil is returned. In case the oil is not in first class condition, suggestions as to treatment are given.

ABSOLUTE ZERO OF TEMPERATURE

A simple explanation of the method arrived at in finding absolute zero of temperature is as follows. If we take for example 493 cubic inches of hydrogen, oxygen, or air, at a temperature of 32 degrees and keeping them at constant pressure, not necessarily the same for each, heat them so that their temperature is raised one degree, and their volume has increased by one cubic inch, so that now it is 494 cubic inches. If we again raise them another degree of temperature we find that the volume has increased again one cubic inch, being now 495 cubic inches. If we cool the gas instead of heating it we would find that with each degree of temperature decrease we should have a decrease of volume so that if we cool the gas to zero, we should decrease the volume by 32 cubic inches, making it 461 cubic inches. Now if we were to keep on decreasing it is obvious that when we had reached the zero of volume we would have reached the absolute zero of temperature, which would be at 461 below zero on the Fahrenheit scale. The same reasoning can be applied to the Centrigrade scale, except that in this case the volume at freezing point or zero on the Centigrade scale would be 273 cubic inches, and the absolute zero of temperature 273 degrees below zero or freezing point on this scale.

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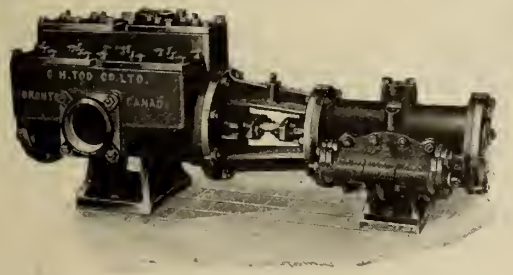

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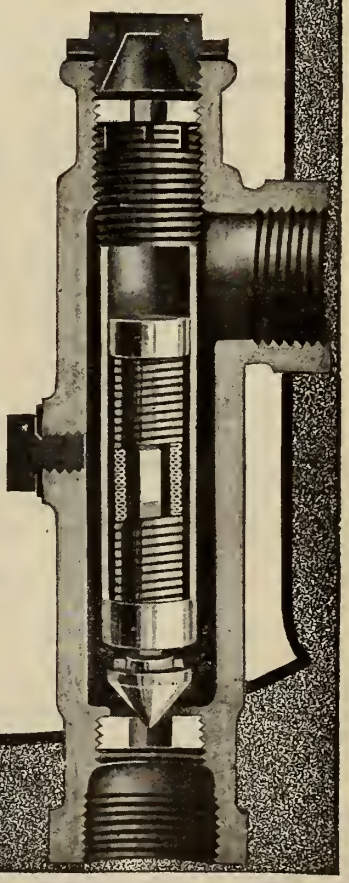

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Size.	Seamless	Lapweld.
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1¼-in.	27 25	.....
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Prices per 100 ft., Montreal and Toronto.

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Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
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¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.99	20.13	19.90	24.04
1½	19.19	24.06	23.79	28.74
2	25.72	20.13	32.01	38.67
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

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4½-in. and larger net.

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Globe	50
Vulcan	50
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Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	15%
Standard	15 to 40%
Cpt leather lacing, No. 1	2 00
Leather in side	2 40 to 3 00

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	17	Atlas	19
Peerless	22	X Empire	14
XX Grand	16	Ideal	18
Superior	21½	X Press	13
X L C R	15		

Colored

Lion	12½	Popular	10
Standard	11	Keen	9
No. 1	14	Fancy	14

Wool Packing

Arrow	30	Anvil	20
Axle	25		

Washed Wipers

Select white	20	Dark colored	13
Mixed colored	14		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	34 00	$39 00
Spelter	7 25	7 50
Lead	6 50	7 50
Antimony	7 25	8 25
Aluminum	28 00	30 00

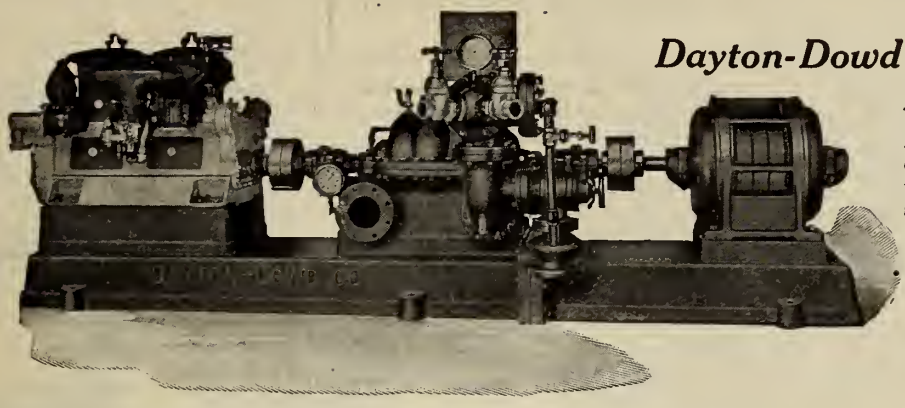
Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.

Cut sheets to size. 1c lb. extra.



Dayton-Dowd Centrifugal Fire Pump

Arranged with dual drive consisting of electric motor and auxiliary gasoline engine. Capacity 500 gallons against a head of 100 lbs., speed 1,450 R.P.M.

DAYTON-DOWD Fire Pumps

Install them for a reliable standby to meet any emergency.

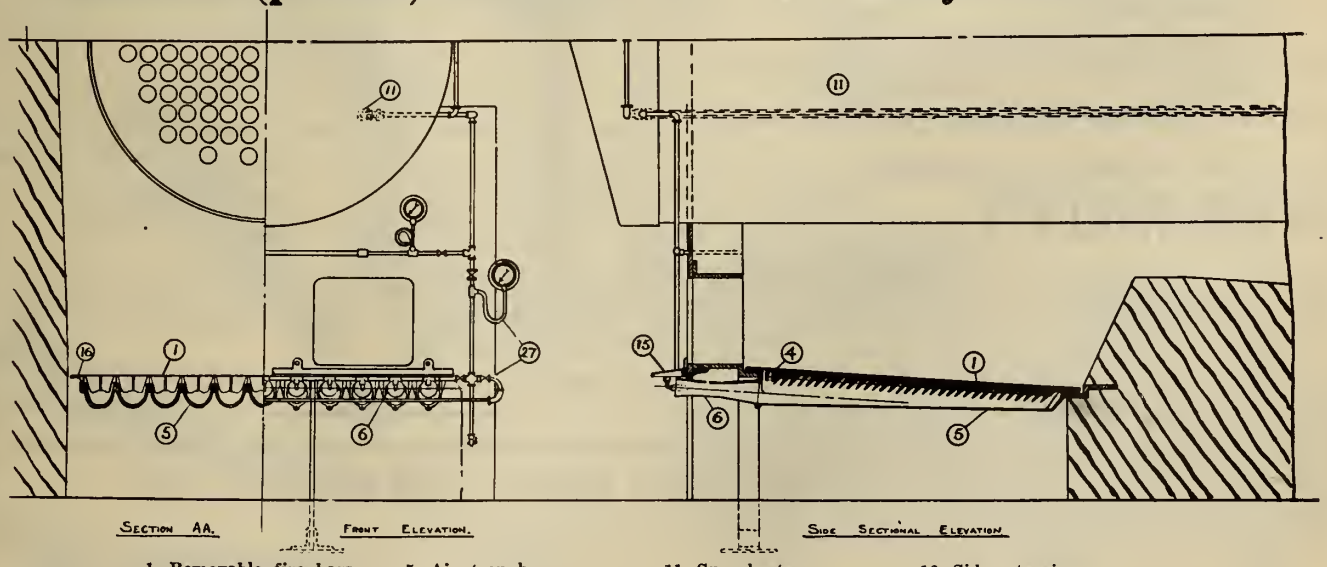
The double drive (consisting of electric motor or turbine and gasoline engine, one on each side of the fire pump as shown above) is a convenient method of installation and affords perfect dependability in case of electric or steam power failure.

This installation is approved by the Canadian Board of Fire Underwriters. Write for bulletins of Dayton-Dowd Pumps for every service.

THE ARTHUR S. LEITCH COMPANY Limited

1001 - 2 Kent Bldg. Toronto, Ontario

Turbine (patent) Furnace for Externally Fired Boiler



1. Removable fire bars. 5. Air trough. 11. Superheater. 16. Side extension.
4. Locking bar. 6. Air injector. 15. Ash guard. 27. Steam fittings.

Also supplied for internally fired boilers. Write for particulars of the performance of the Turbine (patent) Furnace—using coal slack or coke dust. If you have cheap low grade fuel available let us furnish you with full information at once. Over 1,100 of these furnaces are giving satisfactory service in Britain now.

Manufactured by:

The Turbine Furnace Co. Ltd. London, England

Sole Canadian agent:

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Cost per course from $6.00 to $14.00.

Write for full information to Technical College, Halifax, N. S. P2H

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STATIONARY ENGINEER DESIRES POSITION as engineer or fireman. Holds second class certificate, 20 years experience. Apply to Box 151121, Power House.

Answers will be given freely to subscribers to MacLean's Magazine in regard to industrial investments (if a stamped addressed envelope is enclosed) by addressing Financial Editor, MacLean's Magazine, 153 University Avenue, Toronto.

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EXPERIENCED MACHINIST WITH ENGINeer's certificate, good at general repair work desires position. Apply Box 14921 Power House, P2H

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Two 72" x 18' HRT Boilers complete with stack and breeching good for 130 lbs.

One Tandem Corliss Compound Engine Cylinders 14" Stroke 26" x 36" driving wheel 14' x 25" face. 270 HP with 125 lbs. steam pressure. Floor space 31' x 12' with two injectors and Smart Turner Pump. Price $7,500.00. f.o.b. cars, province of Quebec.

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VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings *Forgings*

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Send Blueprints for Quotations. *Write for our latest catalogue*

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Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

"UNIFIC" WATER GAUGE

JOHN MONCRIEFF LIMITED
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GLASSES

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

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Here's what we have done for others:
Sold machinery and power house equipment of all kinds.
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What we have done for others, we can do for you.
Our classified rates are as follows:
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Jointless One-Piece Front Door Arch

Boiler Tube Protectors

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Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

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It is the faithful performance of the exacting duties of power plants that has established the prestige of Tycos Instruments. Their reputation rests upon the knowledge that there is a Competent Tycos Instrument for every temperature problem in the boiler or engine room.

Temperature needs are summarized in a concise and convincing manner in Tycos catalogs. Send for them.

Taylor Instrument Companies

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Tycos ROCHESTER, N.Y.

THERE'S A *Tycos* OR A *Taylor* THERMOMETER FOR EVERY PURPOSE

MADE IN CANADA

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES

40 Standard Patterns in 1000 Sizes

J. H. WILLIAMS & CO., Limited

"The Wrench People"

78 Thorold Road St. Catharines, Ontario

AT NEW ORLEANS, LA.

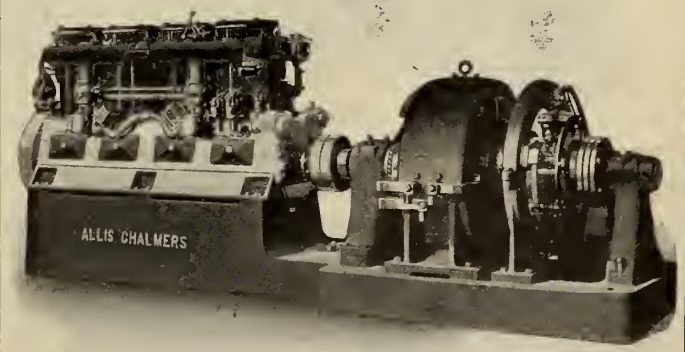
—for emergency a

TRADE **Sterling** MARK

THE ENGINE of REFINEMENT

For the finest boats that float

driven generator



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Catalogue and recommendation on request.

Sterling Engine Co.

Dept. C. Buffalo, N. Y.

High duty gas and gasoline engines, 12 to 300 H. P.

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'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

GODFREY CONVEYORS
Save Time, Labor and Money

In unloading cars and handling coal, coke, ashes, sand gravel and similar materials.

Send for descriptive catalogue No. B-1.

M. A. KENNEDY, Limited
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GODFREY CONVEYOR COMPANY
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The high-class made-in-Canada product which we are putting on the market will entirely justify you in keeping your dollars in this country.

The Smart-Turner Machine Co., Limited
HAMILTON, CANADA

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
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WATER TUBE BOILER

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WATER TUBE BOILER
COMBINES PERMANENT ECONOMY OF OPERATION WITH UNUSUAL ADAPTABILITY TO ANY INSTALLATION REQUIREMENTS.
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GEORGE T. LADD COMPANY
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McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through They have large discharge valves and cannot be flooded from sudden flush of water.

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Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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26 Craig Street - MONTREAL, CAN.

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"MEAD-MORRISON"

SKIP HOISTS

Capacity of this Skip is 32 cubic feet per trip. Operated by Mead-Morrison Electric Hoist.

TRAVELLING WEIGH HOPPERS

McCASLIN CONVEYORS

COAL CRUSHERS

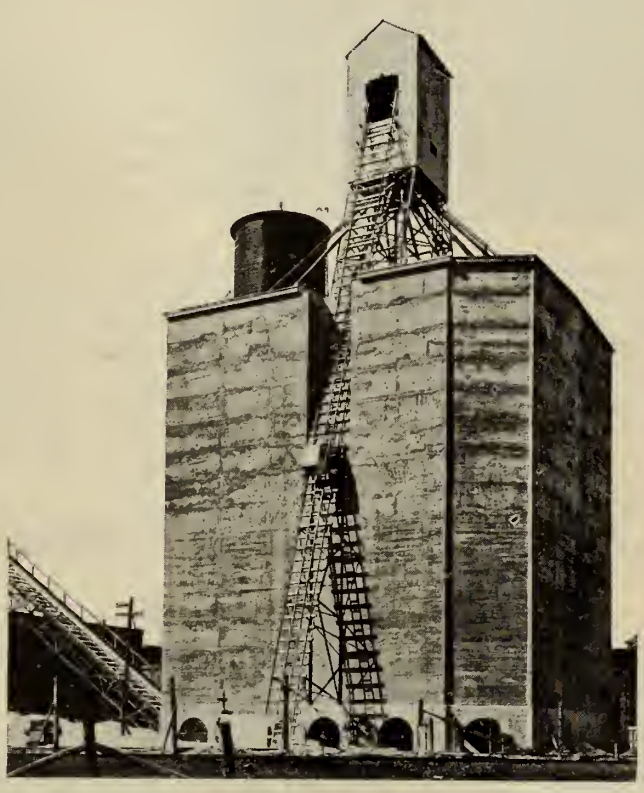
CUT OFF GATES

GRAB BUCKETS

STEAM and ELECTRIC HOISTS

CAR DUMPERS

COAL HANDLING PLANTS



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ENGINEERS MANUFACTURERS CONTRACTORS

Made In Canada
By

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

"Canada's Next Premier"

No matter which he is—all three possibilities are pen-pictured in

November 15 MacLean's

"Scrutator," a writer of rare analytical power, holds the mirror up to Meighen, King and Crerar. Each of the three is "called up" in printers' ink as true to life as if they stood there separate and distinct in flesh and blood. It is one of the most searching, masterly articles ever written with public men as subjects. It is fair to each—and nothing more; a cold-blooded analysis of the virtues and weaknesses of the candidates in turn. It will surprise you, startle you, tantalize you with its subtleness and depth.

"Funny Thing That Tariff"—by J. K. Munro. This number of MACLEAN'S has four timely articles dealing with Big Politics, the whimsical observations of J. K. Munro are, as usual, full of amusement as well as information. Munro just can't help seeing the funny side of politicians and politics. Of Ottawa and Parliament Hill he makes a sort of continuous vaudeville performance. He gets some big laughs out of election activities.

Lt.-Colonel John Bayne MacLean

has been a watcher from the hilltops longer than most of the present-day school of Canadian writing men. As usual, in his article on the Dominion political situation in November 15th, issue of MACLEAN'S MAGAZINE, he strictly maintains the detached attitude of the true journalist. But in his survey of the field and the political gladiators there is a warmth and an intimacy with both the men and the situations that could be imparted only by one who has long been a close and observant student of governments both Dominion and Imperial. This article appears under the caption—

"All Three Are Good Men."

"Our Election Enigma—Women!"—by Agnes C. Laut. How are they going to vote? Are they going to vote at all? Are they going to realize citizenship? These are some of the potent questions asked and answered by one of Canada's leading women authors—Agnes C. Laut. What influence will woman with her vote bear on Canadian politics? Will the woman wage-earner join the ranks of labor when it comes to the battle of the ballots? There is a fund of information for both men and women readers in this right-on-the-minute summary of Miss Laut's.

Other Gripping Features in This Issue:

If you like red-blooded fiction with the tang of the race track in it, W. A. Fraser's short story, **"The Thumb Print,"** is sure to satisfy. It's a case of a pair of sleek double-crossers being neatly double-crossed by what they deemed a rich doubble-crosser.

"Whose Bride Was Mary," is a delightful, fast-reading short story of perplexing situations from the pen of Ethel Penman Hope.

The first of Rev. R. G. MacBeth's thrilling articles on old days with the Mounted Police, "Policing the Prairies," is given complete in this issue. Learn how the Mounties first invaded the prairies in the days of Indian scalp-takers and white "bad men," and in the face of tremendous difficulties.

Incidentally there are two generous instalments of the serials, "Mostly Sally," by Pelham Grenville Wodehouse, and "The Yellow Streak," by Valentine Williams.

What do you know about "Relativity" and the Einstein Theory?—An illuminating summary of Sir Oliver Lodge's explanation of it is one of the many interesting topics dealt with in MACLEAN'S "Review of Reviews."

"Food Facts You Should Know," by William Fleming French, and the regular departments devoted to Finance, Current Humor and Women and Their Work, complete a number bristling with good things.

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McGowan Duplex

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DURABLE PUMPING EFFICIENT
MACHINERY
PISTON AND PLUNGER TYPE
EST. 1852

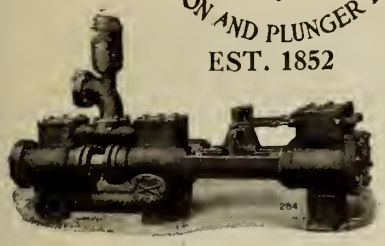


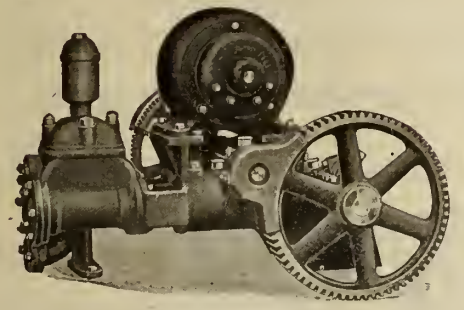
FIG. 7284
Outside Packed Plunger Duplex Steam Pump

cGOWAN Duplex Steam and Power Driven Pumps are built to a high standard of **uniform specifications.** All parts are **interchangeable.** Rigidly tested and made to gauge.

THE STEAM DRIVEN PUMPS are built in both piston and plunger types for all commercial purposes up to capacities of 3,500 gallons per minute. The Power Driven Pumps are built in both piston and plunger types for all commercial uses up to capacities of 500 gallons per minute. Considering the late improvements adapted in our Standard Duplex Steam and Power Driven Pumps, and the consistent high quality of material and workmanship for which they have long been noted, the price is remarkably low.

A full line of patterns for Steam Pumps or belted or direct connected Power Pumps. Order them direct from us.

FIG. 7295
Packed Piston Boiler Feed Pump.



CUT 7374
Motor Driven Duplex Pump.

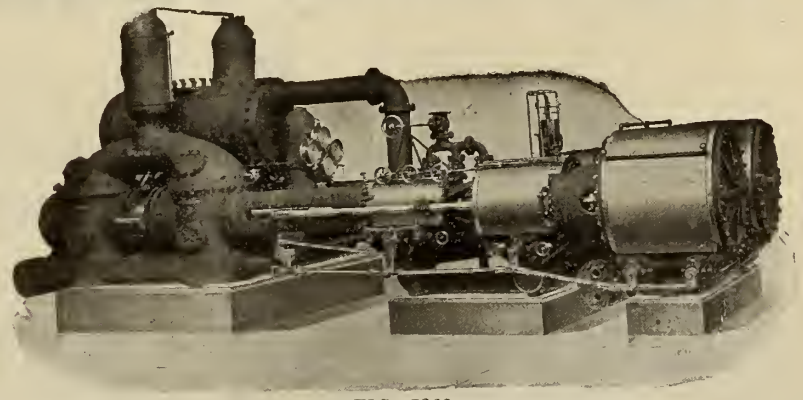


FIG. 7362
Water Works Pumping Engines; Capacities up to 5,000,000 Gallons per Day.

The John H. McGowan Company

General Offices and Works:

54-56 Central Ave., Cincinnati, Ohio

While Nations Discuss "DISARMAMENT"

The vital problem of power house owners should be

More Armament

In selecting either New or Used Equipment keep in mind the good values and careful service that have built our reputation.

Horizontal Boilers
Firebox Boilers
Marine Internal Fired
Tanks
Automatic Engines
Vertical Engines
Horizontal Engines

H. W. Petrie Limited

TORONTO and HAMILTON

CO. LTD.

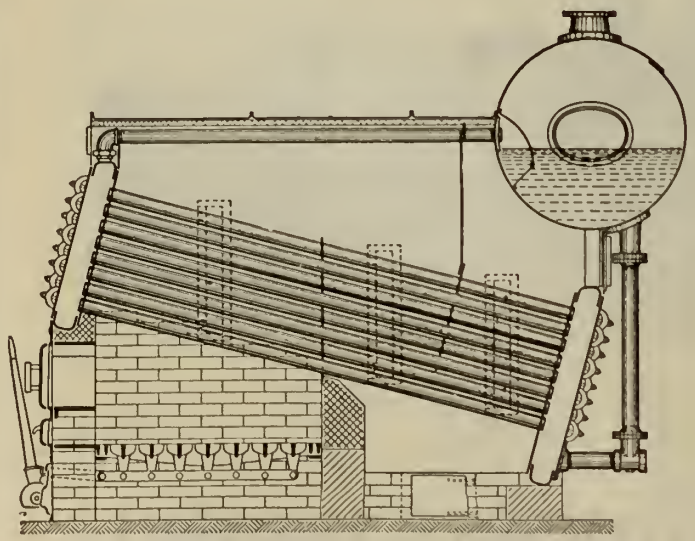
Power Savers

PLIBRICO: Replaces Fire Brick for All Purposes.
PLIBRICO BOND: High Temperature Cements.
PYRO HERMETIC SEAL: For Exterior Settings.
SHELL BAR GRATES: Anticlinker, Revolving.
STAMACO: Automatic Boiler Cleaner.
BOICO & PYRO SCALINE: Feedwater Treatments.
SPENCER DAMPER REGULATOR
VULCAN SOOT CLEANER
AMBEST METALLIC PACKING: All Sizes in a Can.
BULL BEARING ALLOY: Better and Cheaper.

The important function of our organization is to provide a quick and easy way for Canadian Power Plants to obtain the most reputable Fuel and Power Saving equipment and devices. A few of the foremost lines we handle are shown above.

Beveridge Supply Co., Ltd.
628-630 St.Paul St. West, Montreal

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N. S.

Montreal Office:
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20 Victoria Street

ENGINEERS

You Need This Book

"Modern Furnace Building" contains much valuable engineering data, with instructions as to the best methods of installing baffles, side walls, bridge walls, front-door arches—all boiler settings. Illustrations and detailed drawings add interest and value to the book.

Yours for the asking.

DISTRIBUTORS:—Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman, Clancey & Grindley, Calgary, Alta.

JOINTLESS

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Frick Co., Waynesboro, Franklin Co., Pa.
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Can. Fairbanks-Morse Co., Ltd., Montreal.

ARCHES, BOILER AND COMBUSTION
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFINGS
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W. J. Brown (Tucks), Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Durahla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont
R. C. Miller Oil & Supply Co., Ltd., Montreal.

ASBESTOS PACKED COCKS
Beldam Asbestos (Canada) Co., Toronto.
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co., Windsor, Ont.

BALATA BELTING
W. J. Brown (Tucks), Montreal.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Co., Toronto

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS, BRASS
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Millar Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co, Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc Montreal. Que.
Philip Gies Foundry, Kitchener, Ont.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevent Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
C. B. Turner, Toronto.

BOILERS
Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal
C. B. Turner, Toronto.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
C. B. Turner, Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
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Sexton Boiler Setting Co., W. R., Toronto.

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The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

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Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER LINING, PLASTIC
C. B. Turner, Toronto.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill
Betson Plastic Fire Brick Co., Inc., Rome,

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
Philip Gies Foundry, Kitchener, Ont.
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

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Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

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Mueller Mfg. Co., Ltd., The.

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Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

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York Manufacturing Co., York, Pa.

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Can. Link-Belt Co., Toronto, Ont.

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Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

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Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome N. Y.
International Chemical Co., Toronto, Ont.
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Can. Link-Belt Co., Toronto, Ont.

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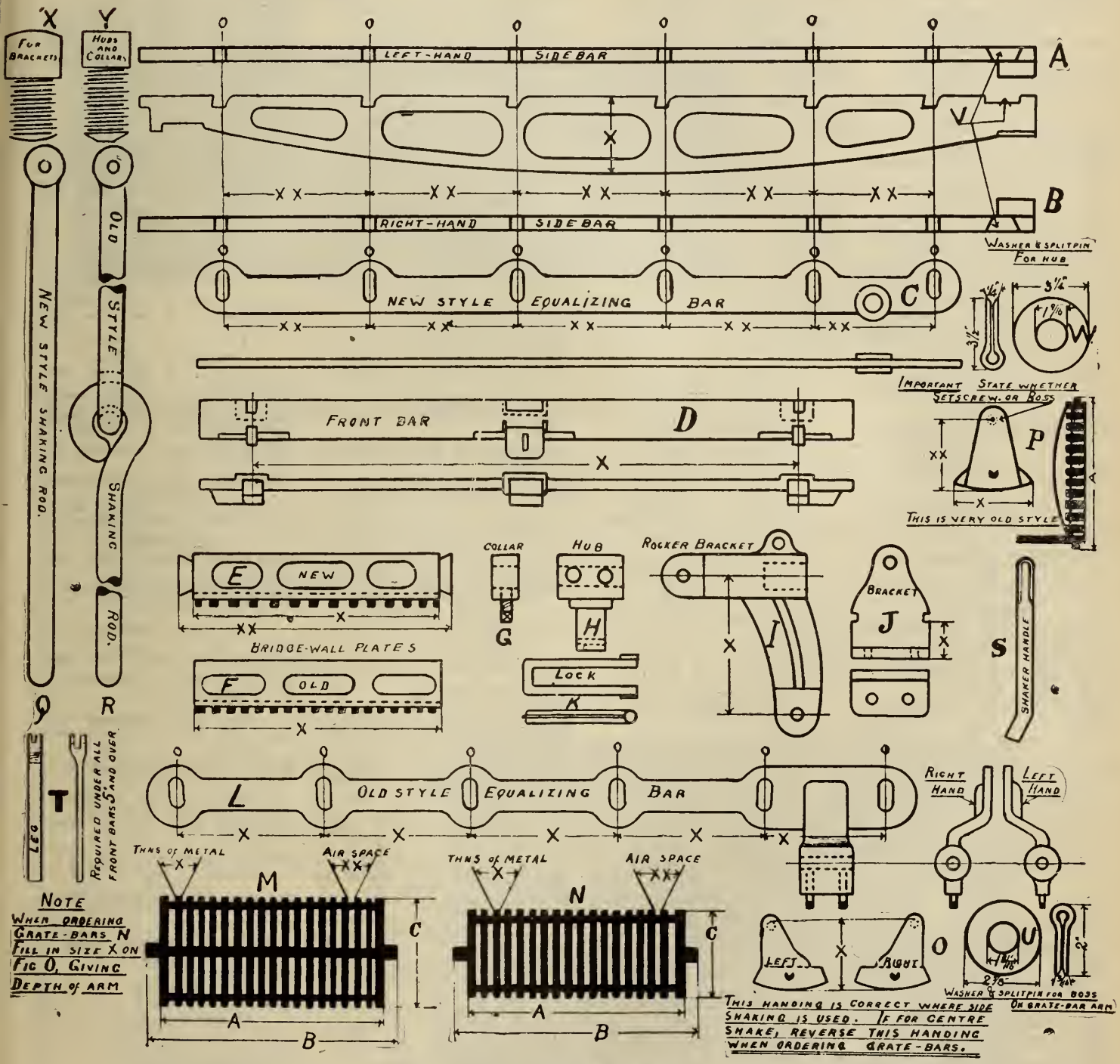

GRATE BARS TO FIT ALL SIZES AND TYPES OF BOILERS.

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Goldie & McCulloch Co., Galt.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOSETS
Mueller Mfg. Co., H., Sarnia, Ont.

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Goldie & McCulloch Co., Galt.
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Godfrey Conveyor Co., Toronto.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

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Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
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Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

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Armstrong Cork & Insulation Co., Montreal, Que.

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Laurie & Lamb, Montreal.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati.
Waterous Engine Works Co., Brantford.

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York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
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Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.

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CONNECTING RODS
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Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

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COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

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Gelinas & Pennock, Reg'd, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

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J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal.

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Laurie & Lamb, Montreal.

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Gutta Percha & Rubber Co., Limited.

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Johns-Pratt Co., The, Hartford, Conn.

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Taylor Instrument Co., Toronto, Ont.

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Jamison Cold Storage Door Co., Hagerstown, Md.

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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

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Lincoln Electric Co. of Can., Ltd., Toronto

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J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal.

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Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
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ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
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Lincoln Electric Co. of Can., Ltd., Toronto
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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Leonard & Sons, Ltd., E., London, Ont.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

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Robb Engineering Works, Ltd., Montreal.

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Goldie & McCulloch Co., Galt.

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

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Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

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Watson & McDaniel Co., Philadelphia.

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Beveridge Supply Co., Montreal.

EYE BOLTS
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Sturtevant Co., B. F., Toronto, Can.

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Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

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Bailey Meters Co.

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Laurie & Lamb, Montreal.
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Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

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FITTINGS
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FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
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FLANGED STEAM FITTINGS
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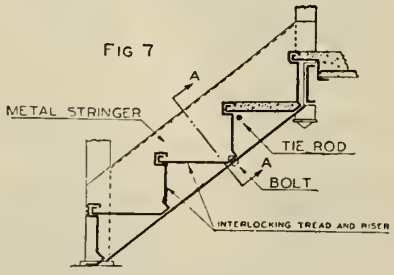

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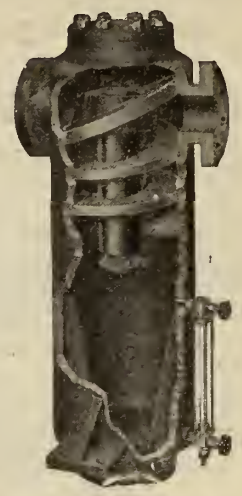

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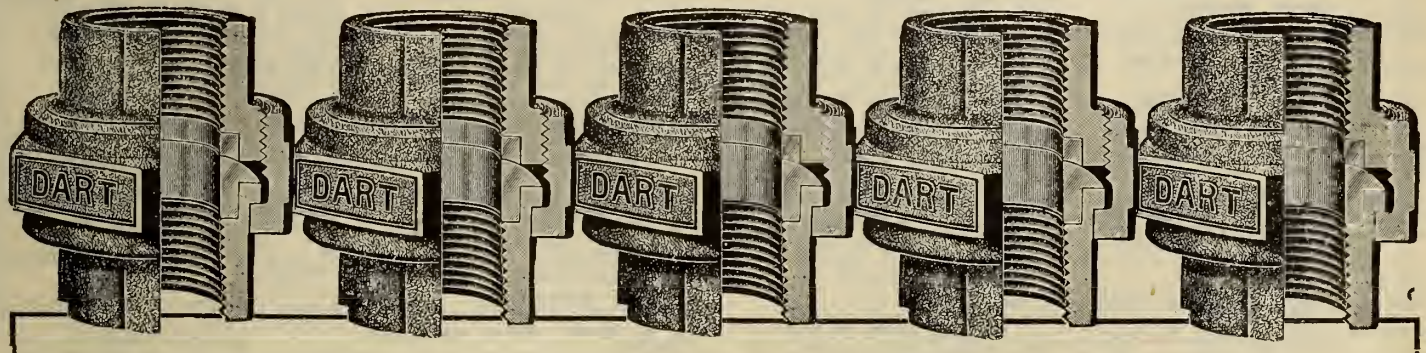

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Pratt & Cady, Hartford, Conn.
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American Steam Pump Co., Battle Creek.
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Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, BILGE.
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal Que
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Smart, Turner Co., Hamilton, Ont.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
S'Este Co., Julian, Boston, Mess.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton
The Fisher Governor Co (Inc.), Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Darling Bros Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sharbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co. Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDEDS CO2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

EXPANSION ENGINES SINGLE, COMPOUND AND TRIPLE
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

Stop Your Firemen Wasting Coal

and secure

Real Boiler Efficiency

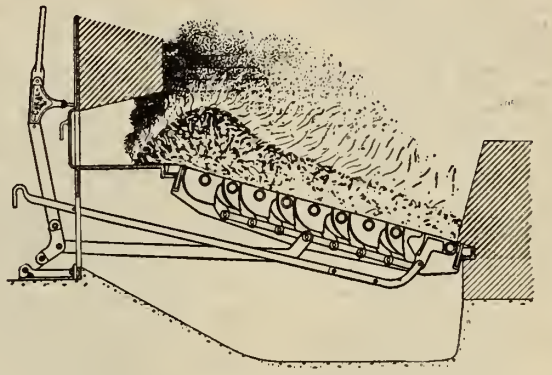

FIG. 1

FIRING

The COKAL SELF-CLEANING HAND STOKER

automatically insures better boiler room conditions and combustion practice. No more hot boiler fronts—no more disagreeable fire cleaning with its inrush of cold air and heavy fuel loss—always ready for peak loads—ash pit losses reduced to a minimum—smoke elimination, and less soot on the heating surfaces—contented firemen and increased efficiency prompted by better boiler room conditions.

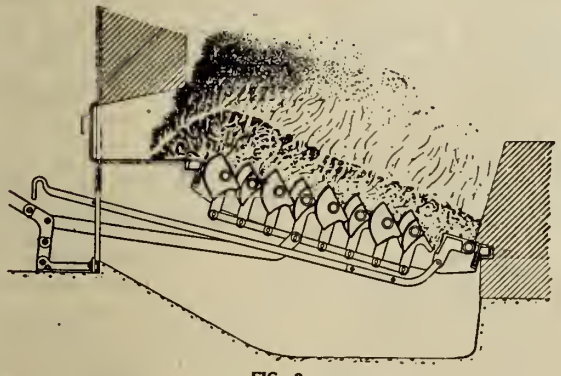

FIG. 2

STOKING

No. 1 **The In-Rush of Cold Air During Cleaning Periods** drops the steam pressure, lowers the furnace temperature and causes heavy boiler strains. Exhaustive tests show that 100 to 200 pounds of coal per boiler are lost "Fighting the Fires" at cleaning time.

No. 2 **Heavy Ash Pit Losses** are caused by the hand cleaning of fires and the extravagant shaking grate. Analysis of your ash pile will show you a fuel loss of all the way from 3 to 12%. Will you stop it?

No. 3 **Smoke During Cleaning Periods** and at other times during operation keeps the Smoke Inspector knocking at your door, you can make a friend of him if you want to.

No. 4 **Your Main Boiler Room Problem today is the human element,** and the use of unnecessary fuel, through incomplete combustion caused by out of date furnace equipment.

No. 5 **Remember, 5 per cent. increase in boiler efficiency,** an additional pound of water evaporated per pound of coal sometimes means the difference between profit and loss.

GELINAS & PENNOCK REG'D

207 St. James Street, MONTREAL, QUE.

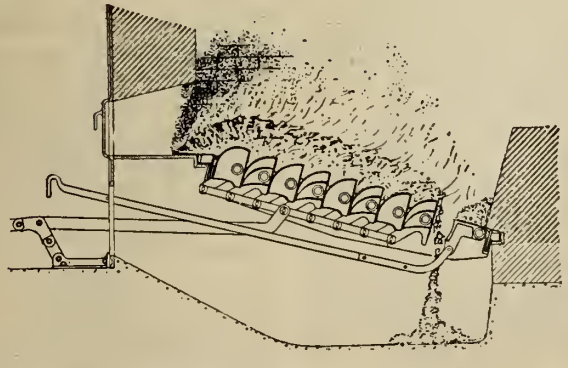

FIG. 3

CLEANING

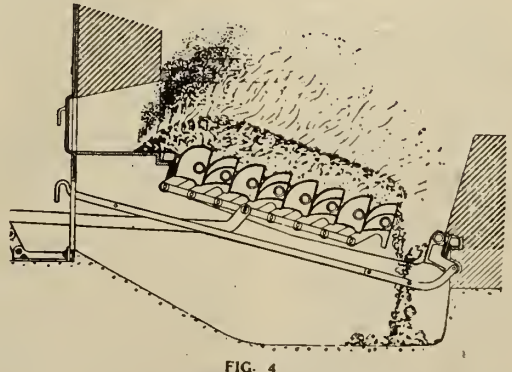

FIG. 4

DUMPING

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM CALORIMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
B. F. Sturtevant Co., Boston, Mass.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM SHOVEL
The Superheater Co., Ltd., Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co. Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Johns-Manville Co. Ltd., Toronto.

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS INDICATING AND RECORDING.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.
Taylor Instrument Co., Toronto, Ont.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co, Julian, Boston, Mass.

TACHOSCOPES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

TACHOMETERS, INDICATING AND RECORDING
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co. St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE PATENT FURNACE
P. A. Goepel, Vancouver, B. C., Canadian Agent.

TURBINES, POWER
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

TUBES, COPPER AND BRASS
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm. Peterboro, Ont
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
B. F. Sturtevant Co., Boston, Mass.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Dart Union Company, Ltd., Toronto, Ont

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
Lunkenheimer Co., Cincinnati, Ohio.
H. Mueller Mfg. Co., Ltd., Sarnia.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Fisher Governor Co., Inc., Marshalltown, Iowa.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Kerr Engine Co., Walkerville, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto
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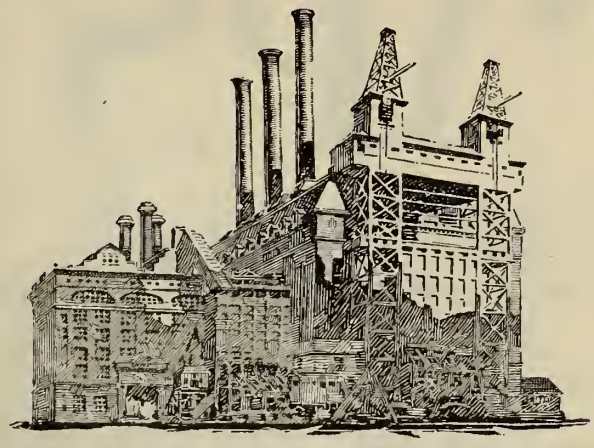

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This Japanese Waterwheel depended entirely upon human foot power

The ancient waterwheel (here pictured) was used in irrigating Japanese rice fields. All day long the coolies treaded the paddles, setting up a current which forced the water into the fields. It is said that these patient coolies often worked themselves into a "trance."

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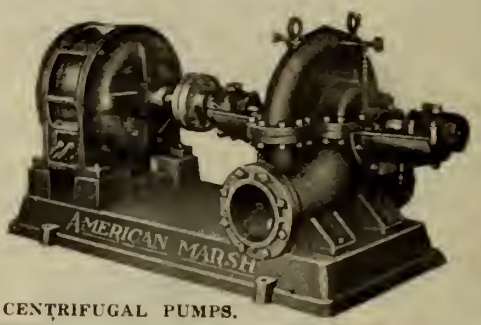

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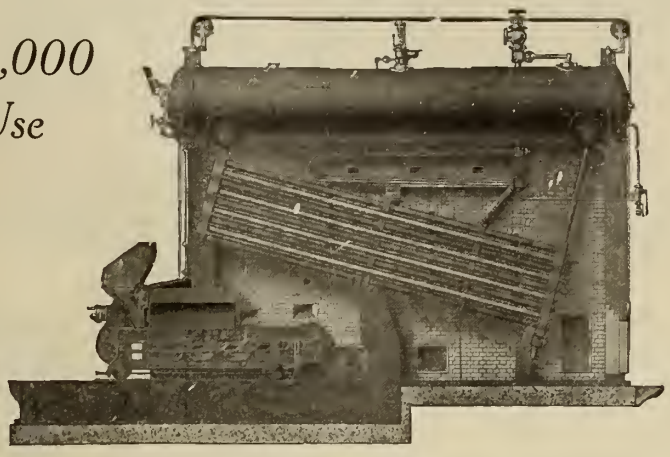

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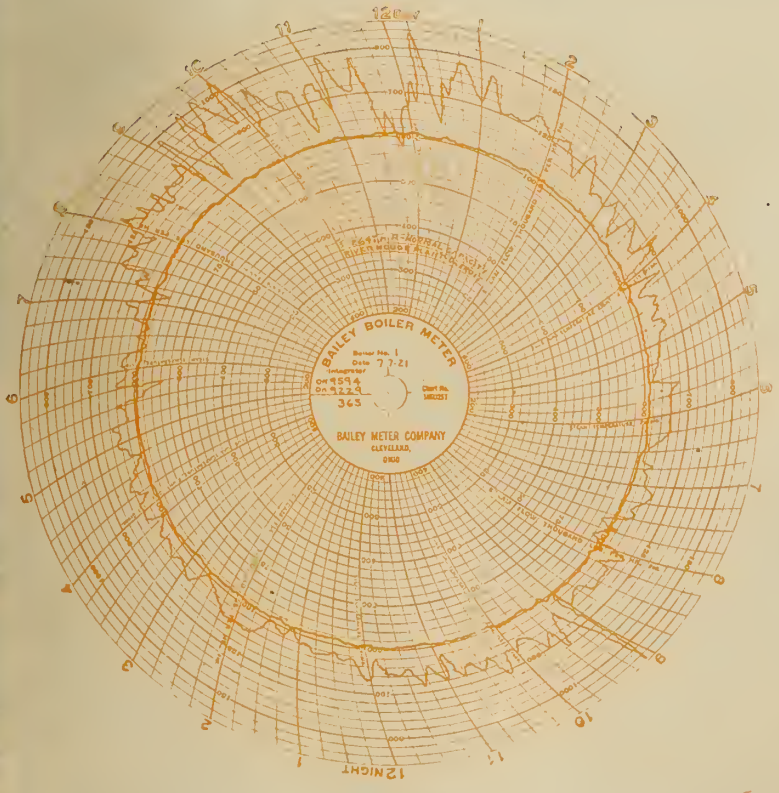
Vol. XIV.—No. 23. Publication Office, Toronto—Dec. 5, 1921 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Constant Steam Temperatures Maintained with Elesco Superheaters



AT THE

Ford Motor Company River Rouge Plant

THE maintenance of superheated steam temperatures nearly constant under a wide range of boiler loads is impressively shown on the chart taken from one of the 2,647 H.P. vertical boilers at the River Rouge Plant of the Ford Motor Co.

The outside irregular line indicates the steam flow which under normal operation at 100% boiler rating is 82,586 lbs. per hour. It will be seen that this varies from 163,000 lbs. maximum 197.5% rating to 84,000 lbs. minimum 101.6% rating.

The even inside line indicates the steam temperature. At normal pressure (225 lb. Gage) the approximate temperature of 200° superheat is 600° F. It will be noted that the variation in steam temperature is very slight, being

615° maximum 2.5% above normal
to 588° minimum 2% below normal

or a variation from maximum to minimum of but 4.5%.

Correct design and proper location of Elesco Superheater units in the gas path reduce variations in superheat to a negligible quantity.

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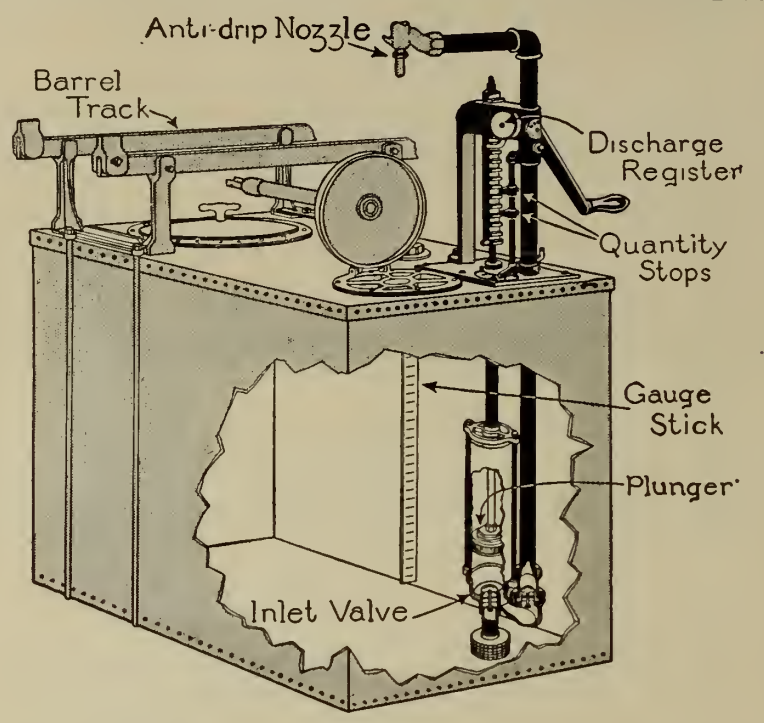

Mechanical Perfection Means Profit Protection

The reasons why Bowser Oil Handling Equipment stores oil economically and safely are shown in the above drawing of the Fig. 64.

The Tank, being riveted and soldered from inside, is absolutely and permanently leak proof.

The Pump is rapid in action and equipped with mechanical measuring stops. A liquid test before shipping assures accuracy.

A permanently tight tank avoids lóss from leakage—it prevents contamination of oil, and keeps the oil room clean. Thus cleanliness is stimulated on the part of the employee.

The Piston-Type Measuring Pump quickly and accurately delivers any desired quantity directly into the receptacle. This prevents overflow of oilers—saves time and oil.

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They insure clean fires all the time, without necessitating slicing, poking through open fire doors. Moving a few convenient levers mounted on the boiler fronts sifts the ashes, cleans the fire, breaks up all clinker and dumps the refuse into the pit. The labor saving is nearly as great as the coal saving.

The illustration shows a typical Files installation. Files stokers are also furnished with mechanical feed where plant is equipped for it.

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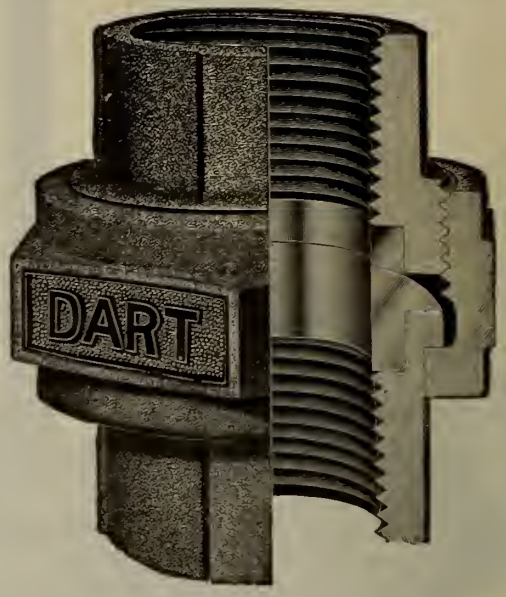

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LABOR (a) The total time required for blowing is cut squarely in two.

(b) There are no lost steps and no lost time between opening of valve and operation of unit.

(c) Only one man is required, no matter how large the boiler. (With other types of blower heads two men are customarily employed on large boilers.)

Under these conditions the cost of labor for cleaning boilers is comparatively small.

STEAM (a) Steam jets are revolving throughout the entire blowing period.

(b) Speed of rotation is controlled by gear reduction. No waste of steam occurs as the result of too slow or too rapid operation.

(c) Globe valves, essential to other heads, require many valuable moments to open and close, during which steam is wasted. The automatic operation of the Valv-in-Head eliminates losses.

The saving in steam with the Valv-in-Head is pronounced, because every bit of steam does effective work in cleaning the boiler.

These are only two of eleven important advantages of Diamond Valv-in-Head soot blowers. Others include savings in pipe, valves and fittings, maintenance, gain in cleaning efficiency, etc., etc.

Every boiler needs a mechanical soot blower and you will save money by buying the best. Ask for your copy of Bulletin 287 describing the new blower.

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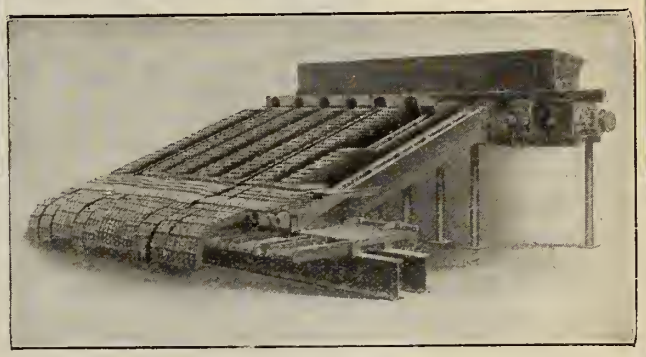
Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

RILEY UNDERFEED STOKERS



View of partially assembled Riley Underfeed Stoker

Unusually Low Maintenance

It was fifteen months after the Stokers were started before any replacements were required at the Parkers Wharf Power Station of the Union Street Railway Company, New Bedford, Mass., except for shearing pins. This installation consists of four six-retort stokers firing 500 H.P. boilers and was put in operation during the spring of 1919. Considering the conditions under which a stoker must work, this indicates good operation and sturdy stoker construction.

But you can expect low maintenance from the Riley—it is built for hard service.

The Riley has moving grates; these keep the fire from holes and the grates evenly covered with coal, preventing burnouts.

The safety shearing pin in the connecting rod of each retort effectively prevents foreign matter from damaging the stoker.

When considering stokers, don't think of the first cost alone, maintenance is an important item.

Send for catalog HM-12 and see how the careful design and construction of the Riley Stoker are keeping maintenance to a minimum in the many plants where they are installed.

SANFORD RILEY STOKER COMPANY
Worcester, Mass.

New Truths and Old Fallacies

ATOMIC VOLUME

Some years ago Professor John Goodman was puzzled to account for the wide difference in frictional co-efficients of alloys of the same composition, tested under similar conditions, which led him to investigate this matter. By having alloys analyzed, he discovered that the presence of impurities of low atomic volume caused the difference and naturally the freer an alloy was of such impurities, the lower the frictional resistance.

The atomic volume of a metal is obtained by dividing the atomic weight by the specific gravity. Below we give the atomic volume of the metals used in babbitt alloys and also of those that would be harmful and classed as impurities, when found in such alloys, viz.:

Elements	Atomic Volume
Lead	18.2
Antimony	17.9
Tin	16.3
Arsenic	13.2
Aluminum	10.6
Zinc	9.1
Copper	7.1
Iron	7.1
Manganese	6.9
Nickel	6.7

All of our experience in this connection confirms the accuracy of Professor Goodman's deductions and justifies the care that we have always observed in the selection and cleansing of metals used in Magnolia, and steering clear of these elements of low atomic volume.

(Continued next month.)

For copy of complete article:

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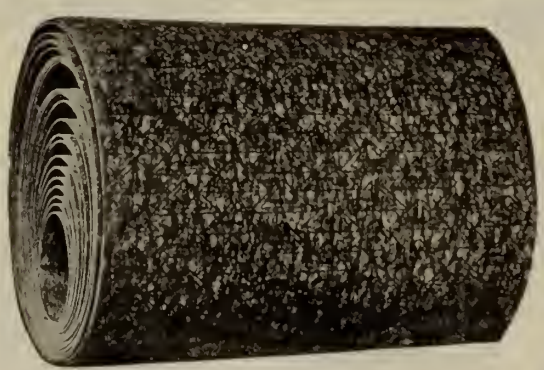

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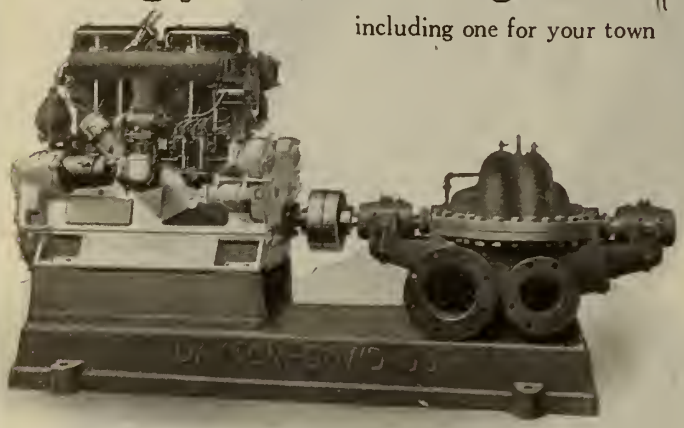

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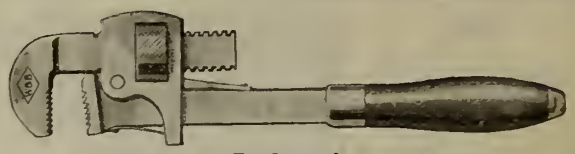

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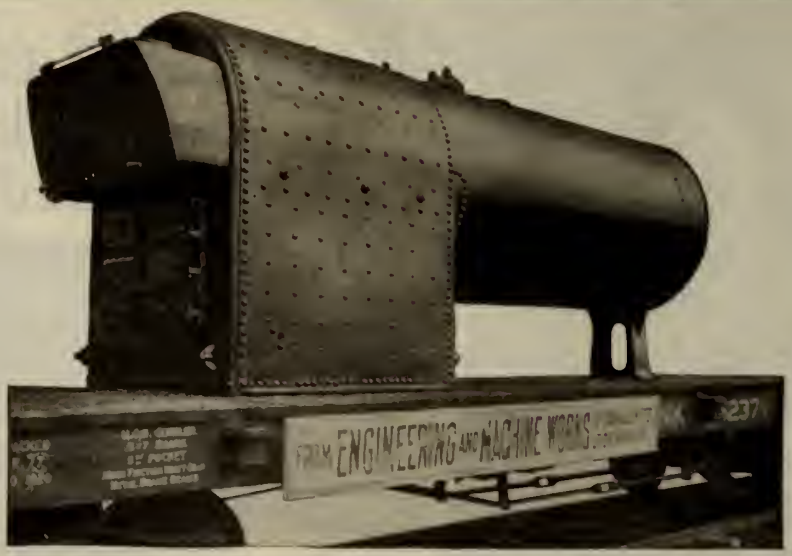


Keystone Fire Box Heating Boiler

The most efficient Boiler you can buy to-day for heating buildings. Built in various styles and in all sizes and with smokeless furnace when required. We have been very successful in building this Keystone Boiler due to our long experience and ample facilities in general boiler making. Prices low.

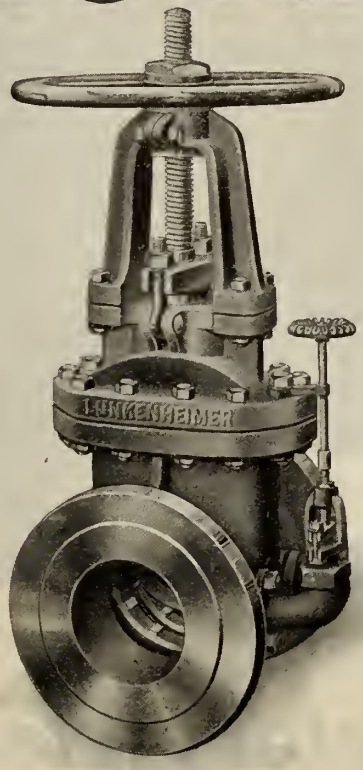
Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices
HALL MACHINE CO., Sherbrooke, Que. and Birks Bldg., Montreal

LUNKENHEIMER

"Victor" Gate Valves



Dependable performance is the service record of LUNKENHEIMER "VICTOR" Gate Valves. The "VICTOR" solid wedge disc, double-faced and guided in its travel, is the most practical design of Gate Valve construction. It eliminates "dragging" across the seatring faces and the consequent wear prevalent in valves employing loose parts.

Highest quality materials, coupled with the LUNKENHEIMER method of manufacture; bearings bronze bushed to minimize wear; the indestructible gasket between the bonnet and body flanges and all parts, including the seatrings renewable, all tend to enhance their value and insure longevity.

Made of Iron, bronze mounted, in both Inside Screw Stationary Stem and Outside Screw Rising Stem types, in four weights for pressures ranging from 100 to 250 pounds. Also in Quick-opening Sliding Stem type for pressures from 125 to 50 Pounds, depending on the size.

"VICTOR" Gate Valves are also made in Bronze for pressures up to 250 pounds, and in Cast Steel for pressures up to 350 pounds and temperatures to 800 deg. F.

Specify LUNKENHEIMER "VICTOR" GATE VALVES and insist on their installation. Distributors of LUNKENHEIMER Products situated in every commercial centre.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF HIGH GRADE ENGINEERING SPECIALTIES IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST. NEW YORK

CURRENT EDITION OF CATALOG BEARS No 58 COPIES PROCURABLE FROM LUNKENHEIMER DISTRIBUTORS

6-24-43

Vulcan Soot Cleaner installed in a 313 H.P. Oil Burning Goldie & McCulloch Boiler. Imperial Oil Co., Regina, Sask.

For the Sake of Economy

Vulcan Soot Cleaners are a necessary part of the boiler equipment now that Economy has once more become the guiding star of business.

They lower stack temperature—increase steam capacity and production—reduce labor cost—save between 4 per cent. and 8 per cent. of the total fuel consumption—and do twice the soot cleaning that is possible with the hand lance.

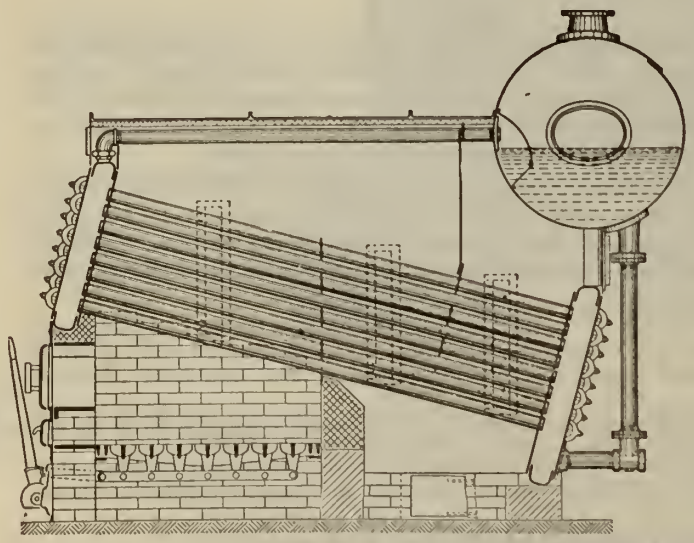
There is a Vulcan Bulletin describing the Cleaner especially designed for your Boilers. Let us send it to you. Address any of our offices.

VULCAN Soot Cleaner Company

Main Office: Du Bois Pa. Offices in 30 Cities

TORONTO—Green's Economiser's Ltd., Kent Building.
WINNIPEG—Wm. W. Hicks & Co., 567 Banning St.
MONTREAL—Beveridge Supply Co., Ltd.

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

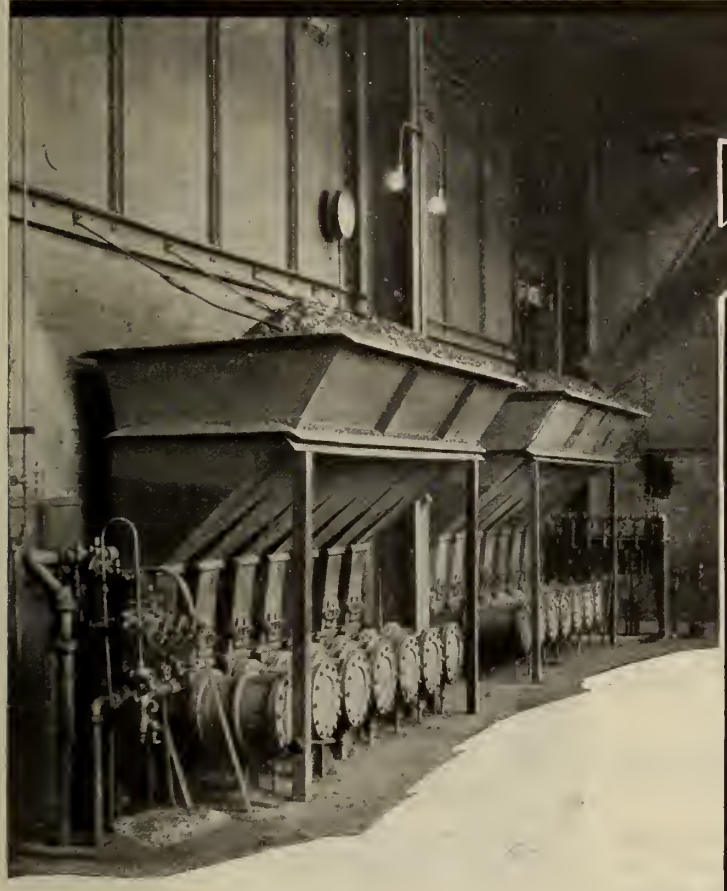
It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N. S.

Montreal Office:
16 Cathcart Street

Toronto Office:
20 Victoria Street

JONES STOKERS



POWER interruptions will not, and should not, be tolerated in modern plants. That is why Jones Stokers are favorites for plants of practically every size. Their rugged simplicity makes shut-downs for repairs next to impossible. Fuel and air are automatically controlled; little attendant labor is required.

In the "A-C" (Automatic-cleaning) type, fires are automatically cleaned.

Retorts may be individually controlled —an exclusive feature.

Clinkers do not form on bridge or side walls.

The under-feed principle of combustion (originated in Jones Stokers) insures maximum economy of fuel at all loads.

These, and other distinctive features that make the Jones Stoker "pay for itself—then pay dividends," are covered by the new catalog.

Have you your copy?

The Under-Feed Stoker Co. *of* Canada, Limited

81 Victoria Street, Toronto

Quebec and the Maritime Provinces: The Cleaton Company (Canada), Ltd., Southam Bldg., Montreal.

Alberta and Saskatchewan: Mr. J. Twomey, Camrose, Alta.

British Columbia: E. A. Earle, Ltd., 739 Hastings St. W., Vancouver, B.C.

Winnipeg,
567 Banning St.

The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Limited, has recently been reorganized as The Under-Feed Stoker Co. of Canada, Ltd., and the reorganization makes available for Canadian power users the extensive engineering resources of The Under-Feed Stoker Co. of America.

LINDE

Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

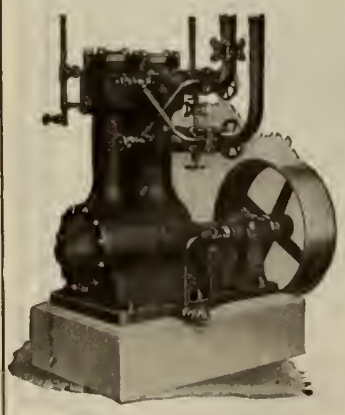
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

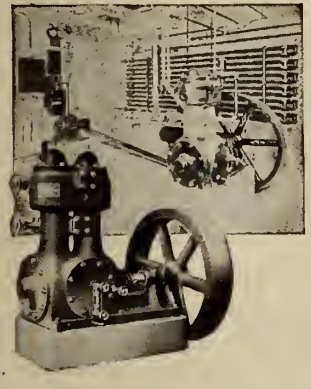
Ask for a copy of our List of Users covering 48 pages of satisfied customers -- also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

A YORK MACHINE DOES NOT REQUIRE A SKILLED OPERATOR



DON'T get the impression that Mechanical Refrigeration means complicated apparatus, difficult to understand and costly to operate. You need have no such fears if it's a YORK installation.

A York plant is the embodiment of simple efficiency. No skilled attendant is required. One of our customers says in testifying to the simplicity of his York plant, "It is being operated successfully by an employee who, prior to the installation of the machine, had never seen one nor had any experience in operating one."

Constant attention is unnecessary. The simple regulation of one valve gives any degree of cold you want—freezing, zero, below zero—whatever your business needs may require.

If you want the simplest, most efficient, most economical refrigerating system, you will investigate the York Refrigerating Plant.

Canadian Representative:

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YORK MANUFACTURING COMPANY

(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA., U.S.A.

JAMISON

Formerly "JONES"

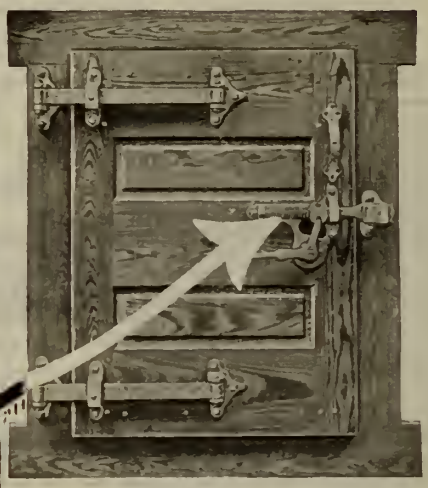
Heavy Duty Cold Storage Doors

In the **Jamison** line of cold storage doors you can get a door exactly suited to your requirements. Made for all conditions and purposes.

Shown here is our Standard Bunker Door—also our Entrance and Bunker Door combined. Special attention is drawn toward the Automatic Self-tightening Fastener and Adjustable Spring Hinges. They are heavier in construction and combine practical features not found in other doors. All hardware in Jamison doors is bolted to the door and frame; no wood screws used.

These are but a few of the features that have won for **Jamison** products the reputation of the **World's Standard** by their long, unfailing performance under all conditions.

Catalogue No. 10 gives complete details—shall we send it?



JAMISON COLD STORAGE DOOR CO.
Formerly
JONES COLD STORE DOOR COMPANY
HAGERSTOWN, MD.
U. S. A.

P⊗H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

P⊗H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office 100 CHURCH STREET, TORONTO, ONT.

There *Is* a Difference

NONPAREIL Corkboard is pure corkboard—100% cork. But it is more than that. Nonpareil Corkboard is pure cork in screened granules of the proper size, thoroughly cleaned of all dust and dirt. Compressed to exactly the right density, it is baked at a temperature accurately gauged to liquefy the natural gum and yet to avoid charring. Nonpareil Corkboard is trimmed to clean straight edges and corners and to unvarying uniformity in length, width and thickness and carefully sorted for defective boards.

Samples may look like it and names may resemble it, but Nonpareil quality is to be had only in Nonpareil Corkboard. That quality is the result of experience and workmanship and is your guarantee of highest insulating value, maximum moisture resistance and longest life in service.

One of the general storage rooms, insulated with Nonpareil Corkboard, in the plant of Noel & Company, Nashville, Tenn.

For your safe guidance in the insulation of all kinds of cold storage rooms, ask for the 152-page book, "Nonpareil Corkboard Insulation." Sent free on request.

Armstrong Cork & Insulation Co., 503 McGill Building, Montreal, Quebec
11 Brant Street, Toronto, Ontario

Nonpareil Corkboard Insulation
For All Cold Storage Rooms

Canadian Association *of* Stationary Engineers

Incorporated May, 1887
Incorporated at Ottawa June, 1917

This Organization is founded on the following principles:

—The better education of its members in the science of steam engineering.
—To protect the competent engineer and his vocation.
—To enroll all competent engineers in this organization.
—To impart information beneficial to the profession.
—To assist members out of employment to obtain the same.
—To procure by legal enactment greater safety in the operation of steam plants.
—The belief that knowledge and ability of one's profession is what is necessary to make success possible.

Brother Engineer:

Did it ever appeal to you to join an association devoted entirely to the interests of the engineering profession; one which by means of lectures, illustrated and otherwise, delivered in the lodge room, tends to keep its members right up to the minute with the progress made in the engineering professions?

If you are interested in an association of this kind, and live where less than fifteen engineers reside, send for a copy of our constitution, and make application to the nearest lodge for membership. If you live where more than fifteen engineers live, get together and send in a written application to me.

The undersigned will be very pleased to give any further information required.

F. HARPER, President Grand Lodge.
89 Bay Street, Kingston.

L. J. ELLIS, Sec.-Treasurer Grand Lodge.
142 East Avenue, N. Hamilton.

R. PERCY SIMS, LIMITED
Consulting Refrigerating Engineers
358 Beaver Hall Square, MONTREAL, Canada

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

CANADIAN PLANET ENGINEERING COMPANY Limited.
WINDSOR ONTARIO
Manufacturers of
PLANET MECHANICAL SOOT BLOWERS
Dealers in power plant specialties, mechanical and hand-fired stokers, valves, steam and vacuum traps, gauges and recording instruments, refrigerating machinery.

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Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations. *Write for our latest catalogue*
Patterns Machine Work

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

All parts made to gauge and interchangeable. Give us opportunity to figure on your pumping requirements.

DUPLEX POWER PUMPS

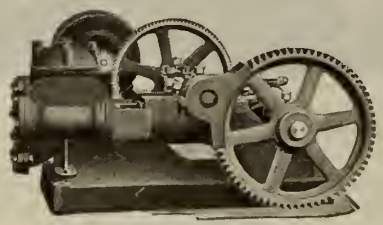

FIG. 7404

Made in piston and outside center packed plunger pumps for both top and side motor mounting.

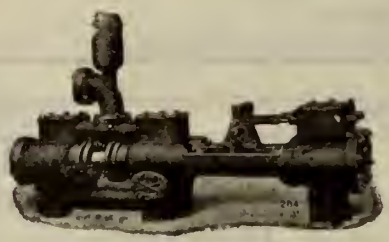

FIG. 7284

BOILER FEED AND GENERAL SERVICE PUMPS

Direct Acting Steam Pumps
For All Conditions of Service and for All Industrial and Public Utility Purposes.

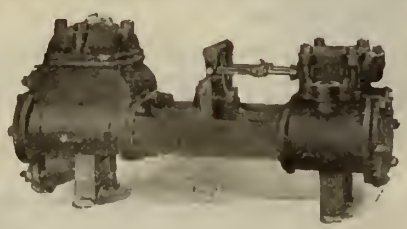

FIG. 7205

PACKED PISTON BOILER FEED PUMP

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

A FURNACE WALL LINING that is free from joints, cracks, falling bricks and mortar. Any workman can make this lining.

Perfect Monolithic Boiler Arches

properly flared for easy firing, durably made with the genuine

BETSON'S

REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF

Here is a splendid repair material for your present Boiler furnace linings, as well as the proper thing to use for front and back arches and gas-tight baffles. Used by thousands of plants with continued satisfaction.

Write for booklet that tells of its usefulness in the boiler room

Betson Plastic Fire Brick Co. Inc.

P.O. Box 386-6, Rome, N.Y., U.S.A.

Canadian Distributors: INTERNATIONAL CHEMICAL CO.,
44-6 Lombard Street, Toronto, Ont., Canada

10,000 Sweet's Separators are serving discriminating steam users around the world.

Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's Separators

DIRECT SEPARATOR COMPANY

218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited

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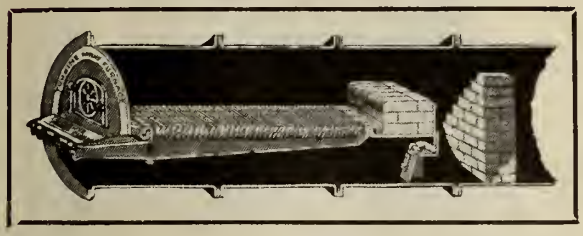
THE TURBINE FURNACE

--HAND FIRED--FORCED DRAUGHT--
FOR
STATIONARY & MARINE BOILERS



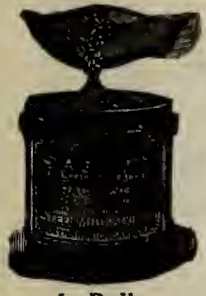
Easy to clean Installed over week-end

GRATES LAST INDEFINITELY

The turbine furnace burns economically such low grade fuels as coke dust—unwashed slack, sawdust, etc. Why burn lump, nut or run of mine coal when you can get the same steam output with any of the cheaper grades and save yourself the difference in the price per ton?

Over 1,100 installations in Britain are giving lasting satisfaction.

P. A. Goepel **AGENT FOR CANADA**
Consulting Engineer
525 Pender St., Vancouver, B. C.



In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.
Drop us a line and let us tell you all about this remarkable packing and our "Safety" Superheat Sheet Packing.

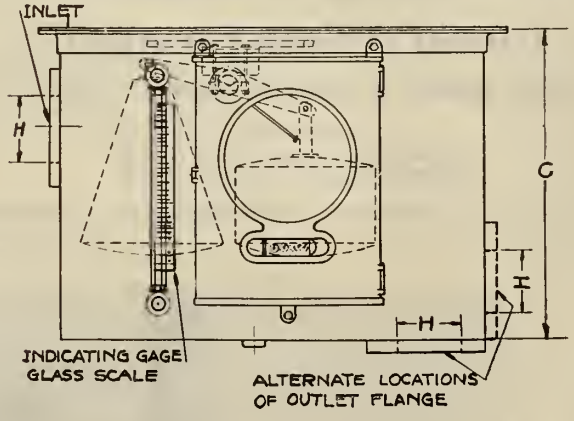
STEEL MILL PACKING CO., WINDSOR, ONT.

In Cotton Tubes

A Bailey Product

The Simplified Way of Measuring Liquids

Illustration shows the operation and general arrangement of the few working parts used in this meter. Note how few adjustments are needed.



BAILEY V-Notch WEIR METERS

For measuring feed water condensate as well as certain other liquids at or near atmospheric pressure, the Bailey V-Notch Weir Meter offers many advantages over the ordinary V-Notch Weir.

The Bailey indicates, records, and integrates the flow of liquids. The pulsating effect of reciprocating pumps does not affect its accuracy. It is extremely simple in construction and is entirely free from troubles arising through the use of cams, springs, racks, gears, and other intricate parts. The Recorder and Integrater are enclosed in a neat iron case and the charts may also show the water temperature.

Write for sizes and complete details.
Bulletin No. 60 tells the story.

Bailey Meter Company

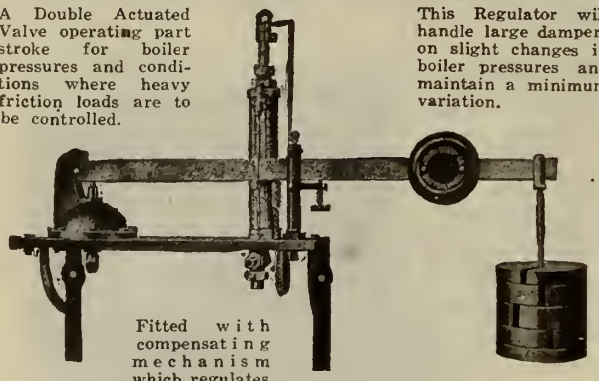
2001 E. 46th St., Cleveland, Ohio

D'ESTE

Hydraulic Damper Regulator

A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.

Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.

Julian d'Este Company

Main Office: 26 Canal St., Boston 14, Mass.

Agencies:
318 W. Washington St., Chicago.
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Tycos

Tycos

TEMPERATURE INSTRUMENTS
INDICATING-RECORDING-CONTROLLING

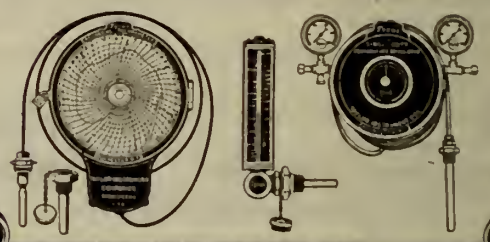
Temperature Problems

that seem new have, in most cases, been solved for others by Tycos Engineers. Your problems are our concern. Send today for catalogs and data, giving specific needs and firm connection when you write. No obligation.

Taylor Instrument Companies

110-112 Church St., Toronto, Ont.

There's a *Tycos* or Taylor Temperature Instrument for every purpose.



828

Shipment of Four 150-H.P. (72"x18) Return Tubular Boilers for 150 lbs. working pressure.

E. LEONARD & SONS, Limited
Head Office & Works, London, Canada
Branches and Agents from Coast to Coast
Established 1834

LEONARD

CATCH THE CINDERS

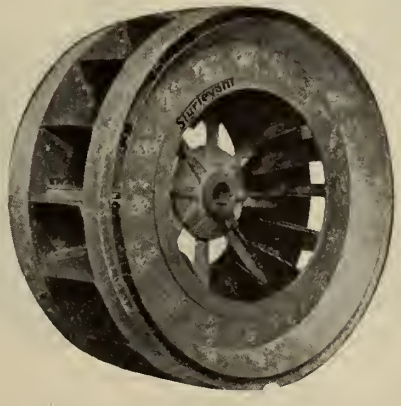
Cinder-Eliminating Induced-Draft Fan

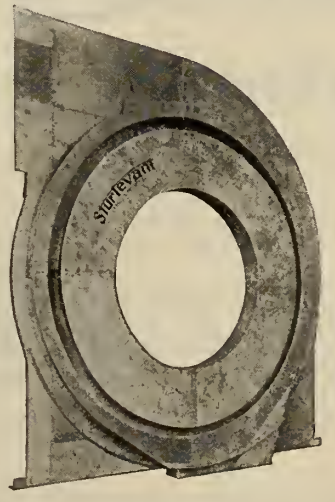
A FAN FOR A DOUBLE SERVICE

1. To eliminate the cinder nuisance.
2. To furnish induced draft efficiently.

Designed to secure both these results in a single unit requiring no more space or attention than a standard fan.

Proved by uniformly successful installations in important plants in large cities throughout the country.

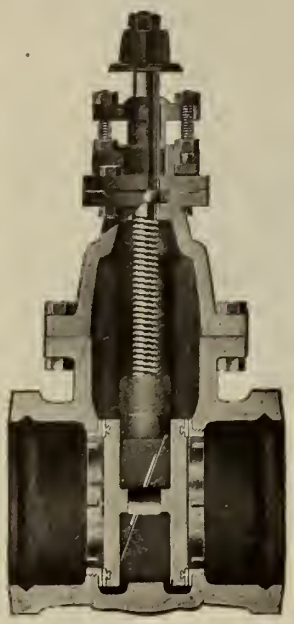




B. F. STURTEVANT CO. OF CANADA, LTD.
TORONTO GALT MONTREAL

Sturtevant

Made in Canada



DARLING
PATENTED
Gate Valve

From TWO to FORTY-EIGHT Inches.

Revolving Discs—Insure long wear because they seat at a different place each time valve is operated, avoiding unequal wear.

Wedging Mechanism—Carries the discs over the port and in front of their seats before spreading and releases the discs from their seats before they start to rise.

Stuffing Box—Bolted pattern with independent gland bolts.

DOMINION STEEL PRODUCTS CO., LIMITED
Brantford, - - Canada,

COPPUS TURBO BLOWERS

In Leading Canadian Plants

Note This List of Users

The T. Eaton Company Ltd. Hamilton.
Canadian National Railways, Leaside and Winnipeg.
Farmers' Dairy Co., Toronto and Indian River.
Lever Bros., Toronto,
Barrett Co., Ltd., Toronto.
Grace Hospital, Toronto.
Simpson Knitting Co., Toronto.
St. Michael's Hospital, Toronto.
Davis Leather Co., Newmarket.
Municipal Abattoir, Toronto.
Canada Foundries & Forgings, Welland and Brockville.
Robt. Crean Co., Toronto.

Interchangeable parts, standardized; the perfected oiling system; the expanded fan casing, and the protection of bearings and oil system against dirt and grit helped in making Coppus Turbo Blowers miracles of steam economy.
We are prepared to solve your combustion problems and explain fully the benefits of COPPUS TURBO BLOWERS and COPPUS TURBO FEED PUMPS. Shall we send you the Coppus Catalogue?

The Arthur S. Leitch Co., Limited
SALES ENGINEERS
1001-2 Kent Building, Toronto, Ont.

It skidded 4000 miles without wearing out

ALL the tires aren't on motor cars. You put tires on your inside packed pump pistons, too. Imagine the difficulty of building a tire that would stand up under a constant sidewise skidding pull for 4000 miles even over the smoothest surface.

Yet this is what Johns-Manville has done by combining a tough asbestos fabric with rubber.

Universal Piston Packing

Universal Piston Packing is folded so that only rounded shoulders can come in contact with the cylinder liners.

This back and forth folded construction provides a wearing surface far superior to the raw edges of laminated packings. It also makes expansion toward cylinder walls possible, taking up wear should it occur—preventing leakage or pump slippage. By vulcanizing Universal Piston Packing in steel molds, the sizes come through with die accuracy.

Raising the standards of "Standard Practice"

Universal Piston Packing is only one example of how satisfaction and saving to users accrue from Johns-Manville engineering and research.

As in the case of Universal Piston Packing—you know that laminated packing was "standard stuff" until Johns-Manville raised the standard on "standard practice."

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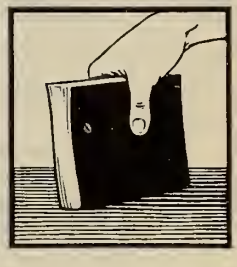

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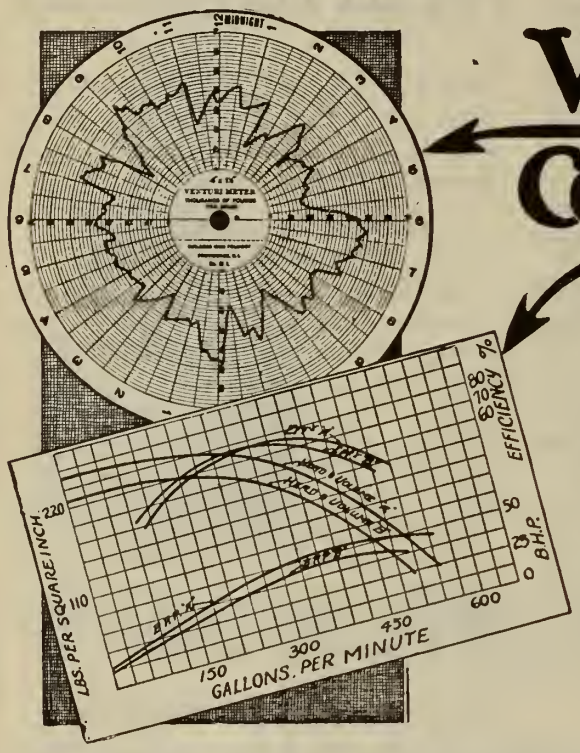

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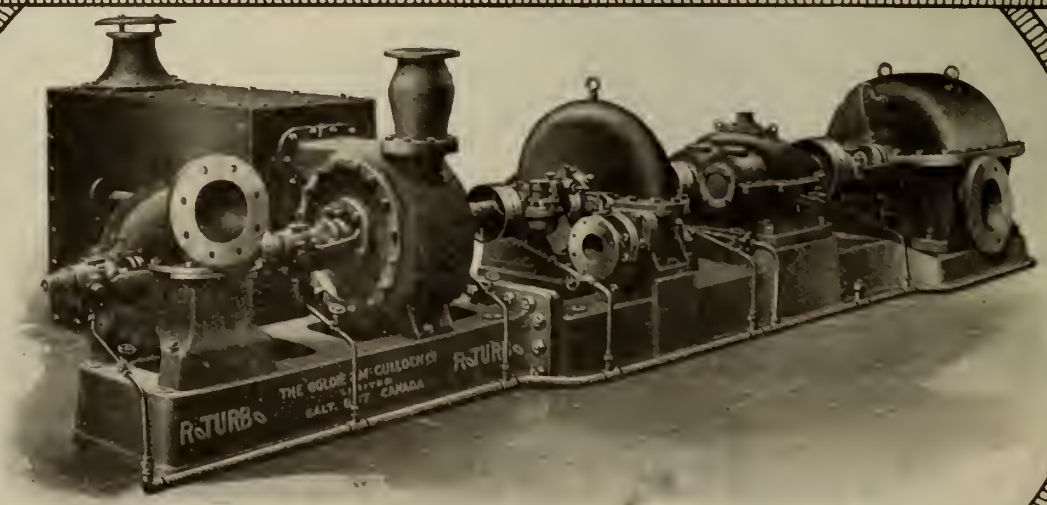

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How to Make Use of Logarithm Tables

In This, the Second Article, the Method of Finding Logs and Anti-Logs Is Shown—Proportional Differences and the Treatment of Logs Having Negative Characteristics Are Also Taken Up

IN OUR last article we gave an illustration of the kind of problem that makes it absolutely necessary to use logarithms. We will not attempt at present to show the method of working that particular problem but will give some illustrations of applying logarithms to ordinary multiplication and division sums.

The cut herewith shows a partial table of logarithms, which are taken to six places of decimals. The column at the left marked N contains the number of which the logarithm is to be found. The next column contains the mantissa of the logarithm of that number, the characteristic being omitted. The reason that the characteristic is not put in is because, as explained in our last article, the characteristic depends on the number of integers, or whole numbers in the number. Thus, if the log. of 415 is sought, the characteristic would be 2. If the number is 41.5 then the characteristic would be 1, while if the number was 4.15 the characteristic would be 0. If the number was .415 the characteristic would be minus 1. .415 would be minus 2, .415 would be minus 3 and so on. The mantissa in case would be .618048, as given in the first column of mantissa. The columns following the one containing the mantissa, and headed 0, are followed by columns headed 1, 2, 3, 4. 5, 6, 7, 8, 9, and a final column headed Diff. The way that these are read is as follows. If we want the logarithm of 4151 we first find the number 415 in the left hand column. The first two figures of the mantissa are 61. Looking under the column headed 1 we find four more figures 8153. The logarithm of 4151 is then 3.618153. The logarithm of 4152 would read by taking the first two figures from the column headed 0, and the next four from the column headed 2, and would be 3.618257, and so on, up to 4159.

Now if we have the logarithm and wish to find the anti logarithm or the number corresponding to the logarithm, we proceed in the opposite manner. If for instance we have the logarithm 2.-618571, fe look up in the table till we find a logarithm beginning with 61 in

LOGARITHMS

COMMON LOGARITHMS OF NUMBERS (*continued*).

No.	0	1	2	3	4	5	6	7	8	9	D.
408	610660	610767	610873	610979	611086	611192	611298	611405	611511	611617	106
409	611723	611829	611936	612042	612148	612254	612360	612466	612572	612678	106
410	612784	612890	612996	613102	613207	613313	613419	613525	613630	613736	106
411	613842	613947	614053	614159	614264	614370	614475	614581	614686	614792	106
412	614897	615003	615108	615213	615319	615424	615529	615634	615740	615845	105
413	615950	616055	616160	616265	616370	616476	616581	616686	616790	616895	105
414	617000	617105	617210	617315	617420	617525	617629	617734	617839	617943	105
415	618048	618153	618257	618362	618466	618571	618676	618780	618884	618989	105
416	619093	619198	619302	619406	619511	619615	619719	619824	619928	620032	104
417	620136	620240	620344	620448	620552	620656	620760	620864	620968	621072	104
418	621176	621280	621384	621488	621592	621695	621799	621903	622007	622110	104
419	622214	622318	622421	622525	622628	622732	622835	622939	623042	623146	104
420	623249	623353	623456	623559	623663	623766	623869	623973	624076	624179	103
421	624282	624385	624488	624591	624695	624798	624901	625004	625107	625210	103
422	625312	625415	625518	625621	625724	625827	625929	626032	626135	626238	103
423	626340	626443	626546	626648	626751	626853	626956	627058	627161	627263	103
424	627366	627468	627571	627673	627775	627878	627980	628082	628185	628287	102
425	628389	628491	628593	628695	628797	628900	629002	629104	629206	629308	102
426	629410	629512	629613	629715	629817	629919	630021	630123	630224	630326	102
427	630428	630530	630631	630733	630835	630936	631038	631139	631241	631342	102
428	631444	631545	631647	631748	631849	631951	632052	632153	632255	632356	101
429	632457	632559	632660	632761	632862	632963	633064	633165	633266	633367	101
430	633468	633569	633670	633771	633872	633973	634074	634175	634276	634376	101
431	634477	634578	634679	634779	634880	634981	635081	635182	635283	635383	101
432	635484	635584	635685	635785	635886	635986	636087	636187	636287	636388	100
433	636488	636588	636688	636789	636889	636989	637089	637189	637290	637390	100
434	637490	637590	637690	637790	637890	637990	638090	638190	638290	638389	100
435	638489	638589	638689	638789	638888	638988	639088	639188	639287	639387	100
436	639486	639586	639686	639785	639885	639984	640084	640183	640283	640382	100
437	640481	640581	640680	640779	640879	640978	641077	641177	641276	641375	99
438	641474	641573	641672	641771	641871	641970	642069	642168	642267	642366	99
439	642465	642563	642662	642761	642860	642959	643058	643156	643255	643354	99
440	643453	643551	643650	643749	643847	643946	644044	644143	644242	644340	98
441	644439	644537	644636	644734	644832	644931	645029	645127	645226	645324	98
442	645422	645521	645619	645717	645815	645913	646011	646110	646208	646306	98
443	646404	646502	646600	646698	646796	646894	646992	647089	647187	647285	98
444	647383	647481	647579	647676	647774	647872	647969	648067	648165	648262	98
445	648360	648458	648555	648653	648750	648848	648945	649043	649140	649237	97
446	649335	649432	649530	649627	649724	649821	649919	650016	650113	650210	97
447	650308	650405	650502	650599	650696	650793	650890	650987	651084	651181	97
448	651278	651375	651472	651569	651666	651762	651859	651956	652053	652150	97
449	652246	652343	652440	652536	652633	652730	652826	652923	653019	653116	97
450	653213	653309	653405	653502	653598	653695	653791	653888	653984	654080	96
451	654177	654273	654369	654465	654562	654658	654754	654850	654946	655042	96
452	655138	655235	655331	655427	655523	655619	655715	655810	655906	656002	96
453	656098	656194	656290	656386	656482	656577	656673	656769	656864	656960	96
454	657056	657152	657247	657343	657438	657534	657629	657725	657820	657916	96
455	658011	658107	658202	658298	658393	658488	658584	658679	658774	658870	95
456	658965	659060	659155	659250	659346	659441	659536	659631	659726	659821	95
457	659916	660011	660106	660201	660296	660391	660486	660581	660676	660771	95
458	660865	660960	661055	661150	661245	661339	661434	661529	661623	661718	95
459	661813	661907	662002	662096	662191	662286	662380	662475	662569	662663	94
460	662758	662852	662947	663041	663135	663230	663324	663418	663512	663637	94
461	663701	663795	663889	663983	664078	664172	664266	664360	664454	664548	94
462	664642	664734	664830	664924	665018	665112	665206	665299	665393	665487	94
463	665581	665675	665769	665862	665956	666050	666143	666237	666331	666424	94
464	666518	666612	666705	666799	666892	666986	667079	667173	667266	667360	94
465	667453	667546	667640	667733	667826	667920	668013	668106	668199	668293	93
466	668386	668479	668572	668665	668759	668852	668945	669038	669131	669224	93
467	669317	669410	669503	669596	669689	669782	669875	669967	670060	670153	93

Partial Table of Logs.

the first column of mantissa. We then look along the other columns until we find the one containing the last four figures of the log. 8571. At the top of this column is the figure 5. The number is then 4155, and as the characteristic is 2 the number will be 415.5.

Now supposing instead of the logarithm or log. as it is usually abbreviated was 2.618469. There is no log. exactly the same as this in the tables. The log. of 4154 is 618466, and the log. of 4155 is 618571. How are we to get the exact number? We must find the proportional difference. and to do so proceed as follows:

The nearest log. below the one we have is 618466, and the number corresponding to this is 4154. Now subtract the log. in the table from the log. whose number we wish to find. Thus 618469 less 618466 gives a difference of .3. Now multiply this difference by 100, which gives 30 and divide it by the number in the difference column,

which is 105. This gives $\frac{30}{105}$ .1857

and this number must be added on the number already found which makes the number 41541857, and if the characteristic was 2 the number will be 415.41857. or 415.4186. The number thus lies between 415.4 and 415.5 and unless the calculation is to be very exact it is usually sufficient to take the nearest log. in the tables and neglect the proportional difference.

In case we wish to find the log. of a number that contains more figures than the tables give, for instance 41569. The characteristic will be 4 and the mantissa will be somewhere between 618676 and 618780. If we wish to get the exact log. we must find the proportional difference. To do this we multiply the figure or figures after the first four, in this case 9, by the number in the difference column. That is we multiply 9 by 105, and divide by 10. Add the quotient to the log. of the first four figures. Thus the log. of 41569 would be 4.618676+9x105945

As we have to divide by 10 this means that we place the 945 under the log. beginning at the second figure from the end thus

```
4.618676
      945
-----------
4.6187705
```

Thus the log. required is 4.6187705

Suppose we wanted the log. of 415698. The characteristic of the log. would be 5 and the mantissa would have to be found by proportional parts. If there is more than one figure over the number to be obtained directly, we must multiply the difference and divide by 100. This is most conveniently done as follows:

Find the log. of 4156 as before which is 618676 as before.

The figures remaining are 98. Then we have log. 415698 =5.618676

```
9x105        945
8x105         840
-----------------
5.61877890
```

As already mentioned, it is but seldom that such a degree of accuracy is required but it shows how simply it can be attained if necessary.

Some Simple Examples

Having made clear just what logarithms are, we are now in a positions to see the actual application in some of the simpler cases. We have stated that in order to perform multiplication of numbers we add their logarithms.

Multiply 4.5 x 4.

```
Log. 4.5 plus log. 4
  .653213
  .602060
-----------
1.255273
```

Then the logarithm of the product is 1.255273. We must look up in the log. table for the anti log. The small part of the logarithm table which we have been able to reproduce here does not contain this log. but it can be found readily by those possessing the full tables. Looking up this logarithm, we find that the anti logarithm is 1800, and as the characteristic is 1, our answer is 18.

Suppose now that we had wanted to divide 4.5 by 4, instead of multiplying we should have had to substract the log. of 4 from the log of 4.5 instead of adding. Thus

```
Log. 4.5 minus log. 4
.653213
.602060
-----------
.051153
```

The anti logarithm of .051153 is 1125, and as the characteristic is nothing the answer is 1.125.

These are simple cases for illustration.

Now let us come to an important application of logarithms, and one where their usefulness will be apparent to all: We mean in the raising of numbers to powers or the extraction of the roots of numbers, in other words evolution and involution, or as many prefer square and cubes and their roots. Instead of the long and abstruse calculations with their immense possibility of error, the use of logarithms substitutes a simple substraction or addition sum, or an even more simple multiplication or division sum. Let us take again the figures 45. We will say first of all that we want to square them, that is 45 x 45.

The log. of 45 is 1.653213, so that we must add the log of 45 to itself to get the log. of 452. This is exactly the same as multiplying the log. of 45 by 2, and as a matter of fact this is what is done. Thus to find the square of 45 we take the log. of 45 which is 1.653213 and multiply it by 2, which gives 3.306426 as the log. of the square of 45. Looking up the tables we find the number is 2025 and as the characteristic is 3.2025 is the square of 45.

Now if we wanted the square root of 45, instead of multiplying its log. by 2 we should divide its log. by 2 Thus the log. of the square root of 45 would

be $\frac{\text{log. } 45}{2}$

```
1.653213
-----------
2
.826606
```

and the anti logarithm of .826606 is between 6708 and 6709. We can find this exactly by the method shown earlier. The next lowest log. to .826606 is .826593 and the difference is 13. The number in the difference column of the log. table is 65, so that we have 1300 divided by 65 which is 20 and the anti-log. of .826606 is 67082, and as the characteristic is 0 the square root log. 45 is 6.7082. It can be readily seen that if we had taken the number corresponding to the next lowest log. it would have made practically no difference in the result in this case.

From these two examples we get the rule. To raise a number to any power, multiply its logarithm by the index of the power. To extract any root of a number, divide its logarithm by the index of the power. To extract any root of a number, divide its logarithm by the index of the power. Here we have a very easily applied method of getting odd powers or roots or fractional powers or roots which it would be extremely difficult to get in any other way. This application of logarithms is worth the study if they are used for no other purpose. We now come to what may be called a special case, although they occur fairly often.

Suppose we have to raise a decimal quantity to a higher power or to find the root of a decimal quantity. Let us take first of all the raising to the 2nd power of a decimal quantity, or getting the square of a decimal quantity, say, .45. Now the log. of .45 is 1.633213 that is the characteristic is a minor quantity. Now how are we to multiply a log. containing a minus characteristic and a positive mantissa. There are several ways of doing this.

Let us take the easiest method first. which is to multiply the mantissa first, and then multiply the characteristic, and then add the two together. Thus we should have .653213 x 2=1.306426, and to this must be added the product of 1 x 2 which is of course 2.

Then we have 1.306426

```
2.
-----------
1.306426
```

The anti-log. of this is 2025 and as we

Continued on page 24

Synchronous Motors and Power Factor

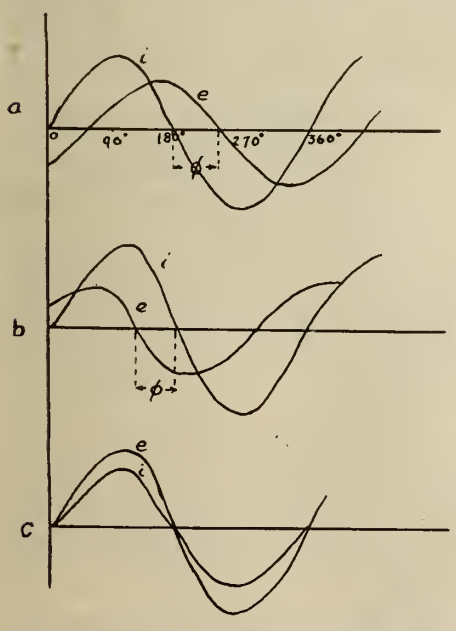
An Article Written in Plain Language, Which Shows the Use of Synchronous Motors in Helping a Higher Power Factor—Power Factor Is Explained for the Ordinary Reader

During the pleasant time of utilizing our natural resources of electric power to the utmost, and considering the high cost of transmission lines, an interesting point in improving the service of electric power and transmission might be discussed; that is the use of synchronous motors or condensers, for power factor correction.

It might be well, before proceeding with the means of correction to briefly disuss the meaning of Power Factor.

It is a well known fact in alternating circuits, that the current and voltage will not usually be in the same phase. That is, as shown in Figure 1, the current and voltage, when plotted throughout a cycle of values will not reach their maximum and minimum values at the same instant of time.

Consider for a moment the plotted curves in Figure 1. These curves are the instantaneous values of current and voltage plotted on intervals of time, and in going from 0 to 60°, they go through a complete cycle of values. In Figure 1a the current is leading the voltage, that is it reaches its maximum, at a definite interval of time before the voltage.



Again in Figure 16, the voltage reaches a maximum value first, and the current is a lagging one. And in 1c the current and voltage are in phase. Again in Figure 1a it is shown that, when the current "i" reaches its zero value the voltage "e" does not reach that corresponding value for an instant of time later and in terms of its cycle, it is Φ degrees behind the current. The fact can be illustrated by means of a victor diagram as in Figure 2. This does not show the complete

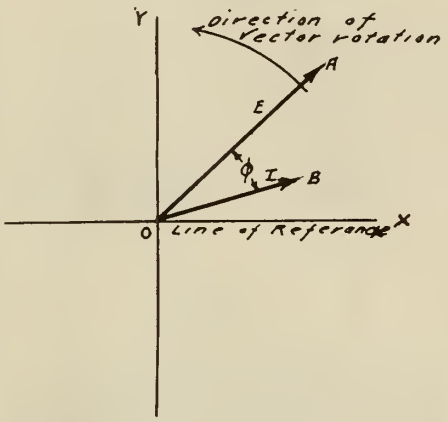


Fig 2.

cycle of values as in Figure 1, but only the value of the current and voltage at the same instant of time. In Figure 2 it shows the voltage victor O.A. leading the current victor O.B. by an angle Φ, and as power is the product of the simultaneous values of current and voltage, the true power must be found, by multiplying the apparent power, by a power factor. This power factor then, has been proved to be, the cosine of the angle of lead or tag, that is, cosine Φ

Thus the relation between power and x current, is cosine Φ.

$$\text{Cosine } \Phi = \frac{P}{E\ I}$$

By way of explanation the cosine of an angle in trigonometry is (for purposes of description, in a right angle triangle) the hypotenuse, divided by the opposite side, that is the side of the triangle made by the angle. Thus when the angle is zero, the side is zero and the cosine of zero is 1, thus the power factor is unity. It is to correct this feature that Synchronous motors are used.

A Synchronous motor may be one of two alternating current generators, operating in parallel on the same bus bars, and the drawing power of one has been removed . It will continue to run at exactly the same speed as before the drawing power is removed. It will be noted that the power is imput, rather than output, as was the case when the alternator was hitched to a drawing power, and it may be termed a synchronous motor.

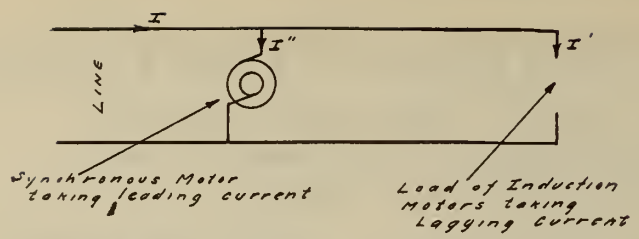
Many manufacturers and users of power are constantly confronted with the problem of too low power factor, (less than unity) and to carry a given K.W. load, at a lower power factor than that originally planned, involves a great many disadvantages. Chief among them are:

1. Large increase of transmission copper cost.
2. Unnecessarily large and expensive generators.
3. Increased cost of distributing transformers and motors.
4. Increased cost for generating station, transforming and switching equipment.

It is pointed out by experts that, in their opinion, the difference in cost necessitated by increasing the carrying capacity of its transmission line, due to its low power factor, might be put to better advantage, by using apparatus to raise the power factor more nearly to unity. Of course it must be considered, as to whether the line will be required to carry a heavier load in the future and also the permanency of the conditions, of the present load, at the distributing end.

The carrying capacity of any electrical circuit, in power, depends on the power factor of the receiving circuit. A certain transmission line, for example, is rated to carry 100 amperes, at 60,000 volts. Hence, when the current and voltage are in phase with one another, the carrying capacity is 6,000 K.W. But the receiving circuit is made up mostly of induction motors and tightly loaded transformers, the current in the transmission line may then lag behind the voltage as much as 45°. Under these conditions the carrying capacity of the line is equal to 60,000 x 100 x cosine 45° = 4240 K.W. Now the earning capacity of the transmission line is only 70.7% of what it is when its carrying capacity is 6,000 K.W. For it must be borne in mind, the fact, the customer pays only for the actual power he uses, that is, E. I. cos. Φ and not the apparent power E. I.

It is therefore advantageous for transmission line owners to contract with customers in such a way as to bring about a high power factor in its line. This can be done if a customer using a synchronous motor is persuaded to run the motor with an over excited field. When such an arrangement is not possible, it generally pays transmission line owners, on long, expensive systems to initial at the end of the line a synchronous motor. In this case it is likely that the motor will not supply any mechanical load, but that it will merely float on the line with the field considerably over excited. In such a case it is called a Synchronous Condenser. Although these machines are designed primarily for power factor correction, they will carry a coupled mechanical load equal to 70% of normal

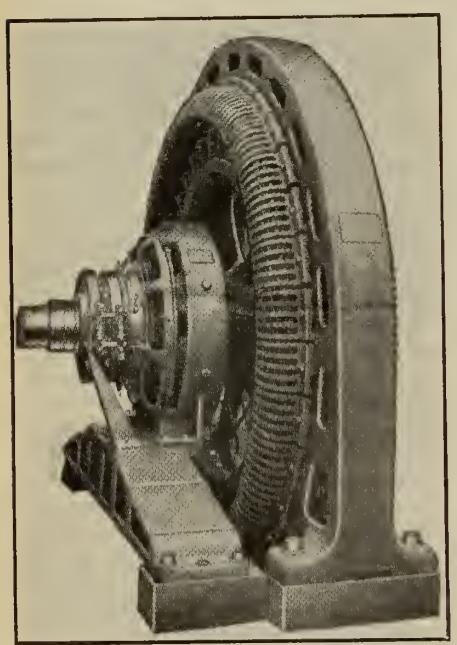


rating in K.V.A., with very little variation in power factor corrective effect.

Figure 3 shown here will illustrate the operation of such a scheme.

In Figure 4 is shown a circuit electrically equivalent to the armature of an over excited synchronous motor, using "C" a condenser and "R" a resistance. It can be proved that this circuit with the proper proportioning of R and C is the exact equivalent of the synchronous motor. Hence, when a motor is used, as in Figure 3 on the line it is called a synchronous condenser.

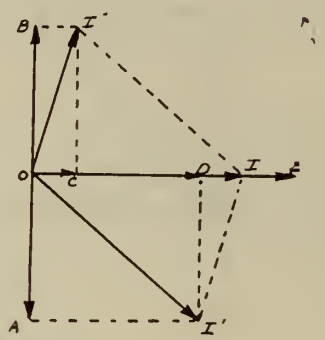
Considering the same situation as



Synchronous Motor With Exciter on Same Shaft.

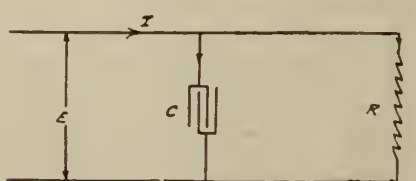
shown in Figure 3, by means of victors as in Figure 5. By this means it can be shown graphically by how much the current may lead or lag behind the voltage. O is the centre and the victors are shown as radii, rotating in a counter clockwise sense about O.

The current supplied to the induction motor is shown as O I (a lagging current) which, it can be proved, can be resolved into two other victors (or components) 90° apart as O.D. and O.A., the resulting effect being the same but it is known that O. D. is in phase with the voltage, and therefore is called an active component of the voltage, whereas O.A. is 90° out of phase with the voltage and is called a reactive component of the voltage. The synchronous condenser current is shown as O.I., which also has two components, O.C. an active component just sufficient to supply its own



losses, and the other O.B. a leading reactive component just equal and opposite to the lagging reactive component of the induction motor O.A. The field of the condenser being overexcited sufficiently to make the above case true. In statistical diagrams of this nature O.I. is the resultant of the parallelogram of which two sides are O.I." and O.I.', or I. is the current in phase with the voltage, which is the victor sum of the leading and lagging currents shown. It is not generally attempted to bring the power factor of the line to unity; this scheme of using synchronous condensers usually results in a power factor from 90—95. That is to say, when the field of a synchronous motor, used for power factor correction is overexcited, there is therefore, a resultant leading reactive or demagnetizing component of its current, which neutralizes the overexcitation, and which is effective in raising the power factor of the connected load, as the line current is the victor sum of the individual currents in the respective apparatus, as shown in the above diagram, and a change in the power factor of one component, brings about a certain resultant variation in the total.

Many companies have found it very satisfactory to install a synchronous mo-



tor in their plants. By way of illustration the generating equipment in one plant consisted of two, 200 KVA, 400 volt, 200 r.p.m., three phase, 60 cycle alternators. A synchronous motor of 250 K.V.A. capacity which corrects power factor and also drives a blower, was installed. Before the installation, the 300 K.W. output of the station was supplied at about 58% power factor. This loaded the generators to the limit of their capacity. Since the installation, the generators are readily carrying a load of 400 K.V.A. which is now at about 95% power factor. This includes a fifty horsepower mechanical load belted to the motor.

The economies effected through the installation of this machine are said to have been such as to pay for it in about a year and a half. When the synchronous motor was first installed, it was possible for a time to carry the entire load with a single engine. It has been necessary to use two generators only since the load has grown.

MONTREAL NO 1 LODGE C. A. S. E.

Montreal No. 1 had an open meeting on Friday, the 25th inst. The chair was taken by Mr. Reynalds, superintendent and director of the St. Lawrence Welding Co. The lecture was on Feedwater heaters and Water Softeners and was fully demonstrated in all its phases by Bro. Henry Wright A. M. E. I. C. Chief Engineer of the Montreal Tramways Co. Power Plant at Hochelaga. Mr. Wright deplored the fact that so few of the manufacturers with steam plants take advantage of the labour saving devices now on the market, and how small was the original outlay, when carried over a number of years, against the cost of mechanical cleaning, year by year. He took the analysis of the St. Lawrence river water and compared it to the water found in many of the Western plants, citing this as a reason why the water softening plants were more numerous there than in Quebec. There were many interesting questions put to the lecturer, and great results were obtained.

HOW TO MAKE USE OF LOGARITHM TABLES

(Continued from page 22)

have a minus characteristic the square of .45 will be .2025.

A second method is to add a positive number to the negative characteristic, and multiply in the ordinary way. After that is performed, the product of the added positive number and the multiplier is substracted from the log. already found.

Using our same figures again for illustrative purposes, we have log. of .45 is $\bar{1}$ .653213. If we add 10 to the negative characteristic we shall have a positive characteristic 9. That is 10 plus 1 is 9. The log. would then be 9.653213 and this multiplied by 2 is 19.306426.

As we have added 10 we must now compensate for that by substracting the product of 10 and 2 which is 20 and the log. will be

19.306426

20.0000000

1.3064260

which is we see the same as before.

In our next article we shall give various examples of logs. applied to the working of actual formula.

What Should The Safety Valve Area Be?

The Writer of This Article Shows What a Great Discrepancy There Is Between the Various Rules in Use and Shows That Practically None of Them Give Sufficient Relieving Capacity

By J. A. McGillivray.

WHAT should be the area of the safety valve? Where is the engineer who has not at one time or other had to answer this question? No doubt he worked it out by some recognized rule or formula. His answer was possibly correct according to the "Rule" adopted by the examining board of his district, state or port, or wherever he was located at the time. But this is where the trouble comes in. There are "Rules" and "Rules," "Formulas" and "Formulas." Why so?

There shouldn't be any disagreement about a good safety valve rule. Yet there are no two that agree with actual tests carried out in this country during the last few years. There are about twenty different safety valve formulas in use on the American continent. Will somebody get up in the Meeting and tell the World what is the meaning of the question anyway, if one man can settle it one way and another a different way and both be right?

Well, some may say those rules "must be right" as there are very few explosions traceable to insufficient safety valve capacity. That so? Do you know why? Isn't it because the safety valve is rarely if ever called upon to do that which it is supposed to do, i. e. to relieve all the steam that can be generated by the boiler when forced to the utmost. When the foreman knows that the load is coming off he checks the fires. There is on one mad enough to force the fires after the safety valves lift. So it may be that in view of the circumstances that the question of a few thousand pounds relieving capacity one way or another does not greatly matter. Well if so, why bother the engineer about it so long as there is a safety valve on the boiler, let it go at that. That is what it amounts to any how and all it will amount to until there is some agreement about rules for boiler construction and boiler safety. But for the present let us consider a given boiler under actual conditions as they came to the writer's notice and we will assume for the sake of argument that some day the safety valve will be called upon to do what it is supposed to do, i.e., relieve all the steam that can be generated by the boiler when forced to the limit under certain conditions of draft, fuel and pressure, etc.

Now I will take for example a boiler upon which I made an evaporation test, some years ago. A boiler which is typical of the modern installation in stationary plants in the United States and Canada and which is insured by a well known insurance company, having two (2) 4½" spring pop safety valves.

The test was run for ten hours, the boiler equipped with a chair grate stoker. During the afternoon we got the furnace temperature pretty high. At one time, during the best hour, the temperature of the furnace was 2470 deg. F.

I have the data for that hour as follows:

Boiler Data.

Com. Rating 600 H. P., Superheat 100 deg. Working press 200.

Water heating surface, 6000 sq. ft.

Grate surface, 110 sq. ft.

$$\left(\frac{H\ S}{G\ S}\right) = 54.54.$$

Test Data

Ave. steam pressure=185 gauge.

Ave. F. W. Temp.=40 deg. F.

Ave. superheat=100 deg. F.

Wt. coal fired=3740 lbs.

Wt. water fed=30,600 lbs.

Factor of evap.=1.3.

Eq. water (F. & A. 212)=39,780 lbs.

H.P. developed=1153=192% comm. rating.

Coal per sq. ft. G.S.=34 lbs.

Water per sq. ft. H.S.=6.63 lbs.

Eq. water evap. per lb. coal=10.63 lbs.

Eff. B.F. & G.=74%.

Heat value of coal used=14229 B.T.U. per lb.

Ave. draft=

$$\frac{42}{100} \text{ inches of water.}$$

The factor of evap. (1.3) is based on Superheated steam at (100°) since the amount of superheating has nothing to do with the safety valve capacity we will have to change the test figures, using the factor for saturated under the test conditions, or feed water at 40° into steam at 195 factor = 1.22.

Then the test becomes

Eq. water evap. from 212 deg. into saturated steam at 212=(30600x1.22)=37332 lbs.

H.P. developed=1080 H.P.

Water per sq. ft. H.S.=6.222.

Eq. evap. per lb. coal=9.98.

Eff. B.F. & G.=68%.

Under everyday operating conditions the feed water temperature is 180 deg. to 200. (Ave. temp. 190 deg.). And when operating at 200 lbs. pressure(the popping point) with an average feed temperature of 190 deg. F. and the same heat transference eff. the amount of water that would be evaporated with such a fire and consequently the weight of steam to be relieved by the safety valve would be equal to the weight of water evaporated into saturated steam on test (30600 lbs.) multiplied by the total heat (H) above the feed temperature per lb. transferred at test, divided by the total heat (H) above the feed (190 deg.) at 200 lbs. pressure.

Under test conditions, total water=30600 lbs.

Under test conditions (H+L)=
[(354.9—8) + (843.2)]
=1190.1 B.T.U. per lb.

Total heat transferred to the water=(1190.1 x 30600) with feed at 190° and steam pressure at 200 gauge, H + L = H =
[(361.4—158) + (837.9)]
=1041.3 B.T.U. per lb. required to evaporate the water into steam.

The total evaporation per hour under working conditions as already stated would be

$$\frac{30600 \times 1190.1}{1041.3} = 38700 \text{ lbs. per hour}$$

to be relieved by the safety valve and this may not have been the limit although I am quite sure it was without an increase of draft. Now these are not supposed conditions but actually existed and might exist again.

Two 4½ spring pop valves having a lift of 1-10 in. would not relieve this weight of steam per hour were they called upon to do so, as we can see by a reference to the table given herewith, as compiled by the Consolidated Safety Valve Company, from actual tests of stationary type spring pops having a lift of 1-10 in.

By reference to the table we find the relieving capacity of a 4½ in. spring pop to be 15,200 lbs. per hour at 200 lbs. gauge. Two of those will relieve 30,400 lbs. per hour or 15% less than the amount that the boiler would generate. Moreover it should be remembered that the average lift is not 1-10 or an inch, the lift of stationary pop safety valves varies from 0.031 to 0.137 with the average at 0.79.

Napiers Formula for the flow of steam air or any gas through an orifice is into some other pressure less than 5-8 of the initial is

$$E = \frac{3600\ A.P.}{70}$$

Where E=wt. discharged per hour.

Where A=the area of the orifice in sq. inches.

Where P=the absolute pressure lbs. per sq. inch.

Size of Valve in inches.	GAUGE PRESSURES (LBS. PER SQ. IN.)												
	60	80	100	120	140	160	180	200	220	240	260	280	300
2"	1890	2400	2900	3400	3900	4410	4910	5420	5920	6430	6930	7430	8940
2½"	2360	3000	3620	4250	4880	5500	6140	6760	7400	8030	8650	9300	9900
3"	3070	3890	4700	5530	6350	7170	8000	8800	9620	10400	11200	12000	12900
3½"	3860	4880	5910	6950	7960	9020	10000	11100	12100	13100	14200	15200	16300
4"	4410	5580	6770	7950	9120	10300	11500	12600	13800	15000	16200	17400	18500
4½"	5310	6730	8150	9570	11000	12400	13800	15200	16700	18100	19500	20900	22400
5	6300	7970	9650	11330	13000	14700	16400	18100	19700	21400	23100	24700	26500

This expression must be multiplied by a co-efficient depending upon the conditions. This co-efficient differs with some authorities. Gebhardts give the co-efficient for safety valves blowing into atmosphere as 0.96, while Babcock & Wilcox use a co-efficient of 0.93 and the Consolidated Valve Company 0.925. The last two being in pretty close agreement and most likely to be substantiated by recent experiments should recommend themselves to general use. Taking the lowest co-efficient since it is better to err on the safe side, where K—co-efficient=0.925, the expression then becomes

$$E = \frac{33600\ A.P.K.}{70} \text{ and } A = \frac{70\ E}{3600\ P.K.}$$

The area of the orifice depends on the lift of the valve and its circumference, that is the circumference remaining the same and the lift is doubled, the area of the orifice is doubled, or the lift being constant and the circumference doubled the area of the aperture is doubled. (NOTE: The area of the orifice varies directly as the dia. and by doubling the dia. the result is the same.)

An example will prove this.

Assume that the relieving capacity of a 4 in. pop valve having a flat seat is to be increased 100%. The lift being 1-10 of an inch.

The area of the orifice=πDL=

$$\frac{3.1416 \times 4 \times 1}{10} = 1.256 \text{ sq. in.}$$

If we double the circumference the area becomes

$$= \frac{3.1416 \times 4 \times 2 \times 1}{10} = \frac{25.12 \times 1}{10} = 2.512$$

sq. inches.

But if we double the disc area of the 4 in. valve we do not double the relieving capacity.

Example:

Area of 4 in. disc = 12.56 sq. in. This multiplied by 2 = 25.12π in. and the corresponding circumference = 17.8 in. and orifice =

$$\frac{17.8 \times 1}{10} = 1.78 \text{ sq. in.}$$

instead of being doubled the area of the orifice is increased only about 42%, so that the only bearing that the disc area has on a safety valve problem is when calculating the load or spring tension required to hold the valve down against the steam pressure.

Practically all spring pop safety valves have 45 deg. seats and the discharge (E) is less than if the seat was flat. When calculating the area of the aperture having a valve with a taper seat the formula becomes

$$A = \pi DL \text{ Cos. } \Theta.$$

Where A = area of the orifice
Where π = 3.1416
Where Z = lift
Where Θ = the angle of the seat.

For a 45 deg. seat Cos Θ = .707. and the formula becomes

$$A = (\pi DL\ .707) = (2.21LD)$$

or combining this with Napier's Formula for a 45° seat.

$$E = \frac{2.21LD\ (360\ A.P.K.)}{7} = \frac{105}{}$$

Then E = (105 L.P.D.)

and $$D = \frac{E}{105\ L.\ P.}$$

Now to show the absurdity of the prevalent idea that the area of the disc is the actual area of the aperture we will take for instance the formula used in the Canadian rules (Interprovincial Regulations adopted by most of the provinces of Canada) Section 272, page 93.

When working pressure exceeds 47 lbs. per sq. in. with coal fuel and natural draft.

$$A = \frac{37.5 \times G}{W\ P + 15}$$

This rule is also in use by the British Board of Trade.

Where A = area of the valve in sq. in. at the point of contact with seat.

Where G = Grate surface in sq. ft.

Where WP = Working pressure lbs. per sq. in. gauge pressure.

Example:

A boiler having 100 sq. ft. of grate. The working pressure being 185 lbs. gauge, find the area of the safety valve, that is required.

Then

$$A = \frac{37.5 \times 100}{200} = \frac{37.5}{2} = 18.75 \text{ sq. in.}$$

If we assume that 18.75 sq. in. is the area of the orifice the relieving capacity would be

$$E = \frac{360\ A.P.K.}{7} =$$

$$\frac{360 \times 18.75 \times 215 \times .925}{7} =$$

1,903,437 lbs. per hour or equal nearly 63,500 boiler H.P. Whereas the actual relieving capacity of such a valve is only about 16,000 lbs. per hour, and the actual area of the aperture or orifice is only 1.08 sq. inches, when the lift is 1-10 in. instead of 18.75 sq. in.

Now we will apply some of the well know rules or formulae to find the size safety valve required for the boiler already discussed and compare the results with the boiler capacity, assuming all to have 1-10 in. lift, the seats having a 45 deg. angle.

Old Rule

$$A = \frac{G}{2} = \frac{110}{2} = 55 \text{ sq. in.} = 8¼ \text{ in.}$$

dia. nearly.

Relieving capacity E = (105 L.D.P.) =

$$\frac{105 \times 8.5 \times 215}{10} = 18{,}906 \text{ lbs. per hr.}$$

Phila. Rule

$$A = \frac{22.5G}{P + 8.62} = \frac{22.5 \times 110}{208.62} =$$

11.86 sq. in. = 3. 7-8 in. dia. say 4 in.
Relieving capacity E = (105 L.D.P. =

$$\frac{105 \times 1 \times 4 \times 215}{10} =$$

9300 lbs. per hour.

Rankin's Rule

$$A = \frac{1{,}406\ W}{P + 8.62}$$

where W = Wt. of coal burned per hr.

$$A = \frac{1.406 \times 3740}{208.62} =$$

25.2 sq. in. = 5¾ in. dia. nearly.
Relieving capacity E = (105 L.D.P.) =

$$\frac{105 \times 1 \times 5.75 \times 215}{10} =$$

13,000 lbs. per hour.

Thurston

$$A = \frac{0.5\ W}{P-10}$$

Where W = Wt. steam generated per hour.

Where P = Gauge pressure.

$$A = \frac{0.5 \times 35{,}000}{210} =$$

83.33 sq. in. = 10 3-8 in. say 10½ in. dia.

Relieving capacity E = (105 L.D.P.) =

$$\frac{105 \times 1 \times 10\frac{1}{2} \times 215}{10} =$$

23,703 lbs. per hour.

B. O. T.

$$D^2 = \frac{\text{Grate area in sq. in.}}{3 \times \text{absolute pressure}} = \frac{110 \times 144}{3 \times 215} = \frac{15840}{645}$$

$D^2 = 24.56$.

$D = \sqrt{24.56} = 4.95$ say 5 in. or its equivalent.

Relieving capacity = (105 L.D.P.) =

$$\frac{105 \times 1 \times 5 \times 215}{10} =$$

11,300 lbs. per hour.

U. S. Supervisors of Steam Vessels

Old Rule

$$A = \frac{HS}{25} = \frac{6000}{25} =$$

240 sq. in. = 17¼ in. or its equivalent.

Relieving capacity = (105 L.D.P.) =

$$\frac{105 \times 1 \times 17.5 \times 215}{10} =$$

39,500 lbs. per hour.

U. S. Supervisors New Rule

$$A = \frac{0.2074\ W}{\text{Abs. pressure}}$$

Where A = sq. in. of safety valve required per sq. ft. G. S.

Where W = Water evap. per sq. ft. G.S. per hr.

$$A = \frac{20.74 \times 352}{215} \times 110 =$$

37.35 sq. in. = 7 in. dia. nearly.

Capacity E = (105 L.P.D.) =

$$\frac{105 \times 7 \times 215 \times 1}{10} =$$

15580 lbs. per hr.

Molesworth

$$A = \frac{4}{5} \text{ grate surface} = \frac{4 \times 110}{5} =$$

88 sq. in. = 10 5-8 in. dia. say 10½ in.

Capacity = E = (105 L.D.P.) =

$$\frac{105 \times 1 \times 215 \times 10.5}{10} =$$

23,750 lbs. per hr.

Thurston

$$A = \frac{4 \times \text{coal per hour}}{P+10} = \frac{4 \times 3740}{210} =$$

Dia. = 9½ in. nearly.

Capacity E = (105 L.P.D.) =

$$\frac{105 \times 1 \times 215 \times 9.5}{10} =$$

21,225 lbs. per hr.

Rankin

A = 0.006 water evap. per hour = (0.006 x 35000) = 210 sq. in. = 16½ in. nearly.

Capacity = (105 L.P.D.) = (105 x 1 x 16½ x 215) = 37248 lbs. per hr.

Thurston

$$A = \frac{2\frac{1}{2} \text{ H. S.}}{P+10} = \frac{2.5 \times 600}{215} =$$

Dia. = 9½ in. nearly.

Capacity = (105 L.P.D.) =

$$\frac{105 \times 1 \times 215 \times 9.5}{10} =$$

21215 lbs. per hour.

Mass. Rule

$$A = \frac{770\ W}{P}$$

Where W = Wt. water evap. per sq. ft. of grate surface per second.

And P = Absolute pressure.

$$A = \frac{770 \times 35000}{215 \times 3500} = 34.81 \text{ sq. in} =$$

6½ in. dia. nearly.

Capacity = E = (105 L.P.D.) =

$$\frac{105 \times 1 \times 215 \times 7}{10} =$$

4673 lbs. per hour.

Darling, for Stationary Pop Valves

$$D = \frac{0.068 \text{ H.S.}}{\text{L.P.}} = \frac{0.068 \times 6000}{0.1 \times 215} =$$

19 in. dia.

Capacity = E = (105 L.P.D.) =

$$\frac{105 \times 1 \times 215 \times 19}{10} =$$

43000 lbs. per hr.

For Marine

$$D = \frac{0.095 \times \text{H.S.}}{\text{L. P.}}$$

Where H. S. = Heating surface in sq. ft.

Where L. = Lift of valve.

Where P. = Absolute pressure.

Canadian Rule

$$A = \frac{37.5 \text{ G.}}{P+15} = \frac{37.5 \times 110}{215} =$$

19.18 sq. in. = 6 in. nearly.

Capacity = E = (105 L.D.P.) =

$$\frac{105 \times 1 \times 6 \times 215}{10} =$$

13575 lbs. per hr.

The ratings or capacity of the safety valves as found by the formula (105 L. P.D.) are less than the actual capacity of the valves under test. This point can be discussed later on.

By application of 13 different rules the safety valve capacities given for a boiler having 6000 sq. ft. H.S. and 110 sq. ft. grate working pressure 200 lbs. gauge having natural draft, burning 34 lbs. coal per sq. ft. of grate, and evaporating 5.83 lbs. of water per sq. ft. H. S. Total evaporation per hour from feed water at 195 deg. into steam at 200 gauge 37,332 lbs. are as follows:

Rule 1 Old English	18,906 lbs per hr.
Rule 2 Philadelphia	9,300 lbs. per hr.
Rule 3 Rankin	13,100 lbs. per hr.
Rule 4 Thurston ..	23,703 lbs. per hr.
Rule 5 Brit. B.O.T.	11,300 lbs. per hr.
Rule 6 U.S. Supervisors (old)	39,500 lbs. per hr.
Do., (new)	15,580 lbs. per hr.
Rule 7 Molesworth.	23,750 lbs. per hr.
Rule 8 Thurston ..	21,225 lbs. per hr.
Rule 9 Rankin ..	37,248 lbs. per hr.
Rule 10 Thurston .	21,225 lbs. per hr.
Rule 11 Mass	14,673 lbs. per hr.
Rule 12 Darling ..	43,000 lbs. per hr.
Rule 13 Canadian .	13,575 lbs. per hr.

Out of 13 rules only three that give sufficient relieving capacity, when the application of the formula A = (105 L. D.P.) gives a valve in excess of 4½ in. dia. the nearest number of valves whose combined circumference are not less than that corresponding to the dia. found will be the size required.

Example:

If A = 201 sq. in. dia = 16 in. circumference = 50.26 four 4 in. valves are required since

$$\frac{50.26}{4} = 12.56 \text{ in.}$$

(But if we divide the area by 4 we have

$$\frac{201}{4} = 50$$

and a corresponding dia. of 8 in.). You see we have four 4 in. valves whose combined area (12.56 x 4) is only ¼ of the area of the 16 inch but having the same relieving capacity.

The foregoing will be interesting to engineers and we would welcome a thorough discussion of the subject. The engineer rarely has anything to do with the selection of the size of safety valve, (that is the operating engineer at least), but he is required to know all about them and to calculate the size, etc. He can figure his safety valve problems in Canada and be 15 per cent. wrong in Massachusetts, or if he figures them out in Massachusetts he will be 67½% wrong in Philadelphia.

There is a difference of 362% between the results found by some of the rules given here and there are yet more rules all equally disappointing.

Alignment Chart for Indicated Horse Power

By A. E. Pennicuick

The illustration Fig. 1 shows a chart drawn up for the purpose of finding quickly any of the values in the formulae

$$I.H.P. = \frac{PLAN}{33000} \quad \text{or} \quad I.H.P. = \frac{P.A.S.}{33000}$$

where P. mean pressure
L. length of stroke in feet
A. area of cylinder
N. number of strokes per min.
I. H. P. indicated horse power.

In order to balance the chart and reduce the number of scales to a minimum the values for L (length of stroke) and N (number of stroke) are converted into piston speed in feet per min. and the value A (area of cylinder) is for convenience converted into diameters.

To read the chart the dotted lines show two examples which will illustrate the method of procedure in finding the required value.

In the upper example a high pressure cylinder of 30 inches diameter has a mean pressure of 110 pounds per square inch and a piston speed of 560 feet per minute. (stroke 4 feet 6 inches and 62 revolutions per minute.) Find the I. H. P.

Join up with a scale or straight edge the point 110 on pressure scale with the point 30 inches on cylinder diameter scale.

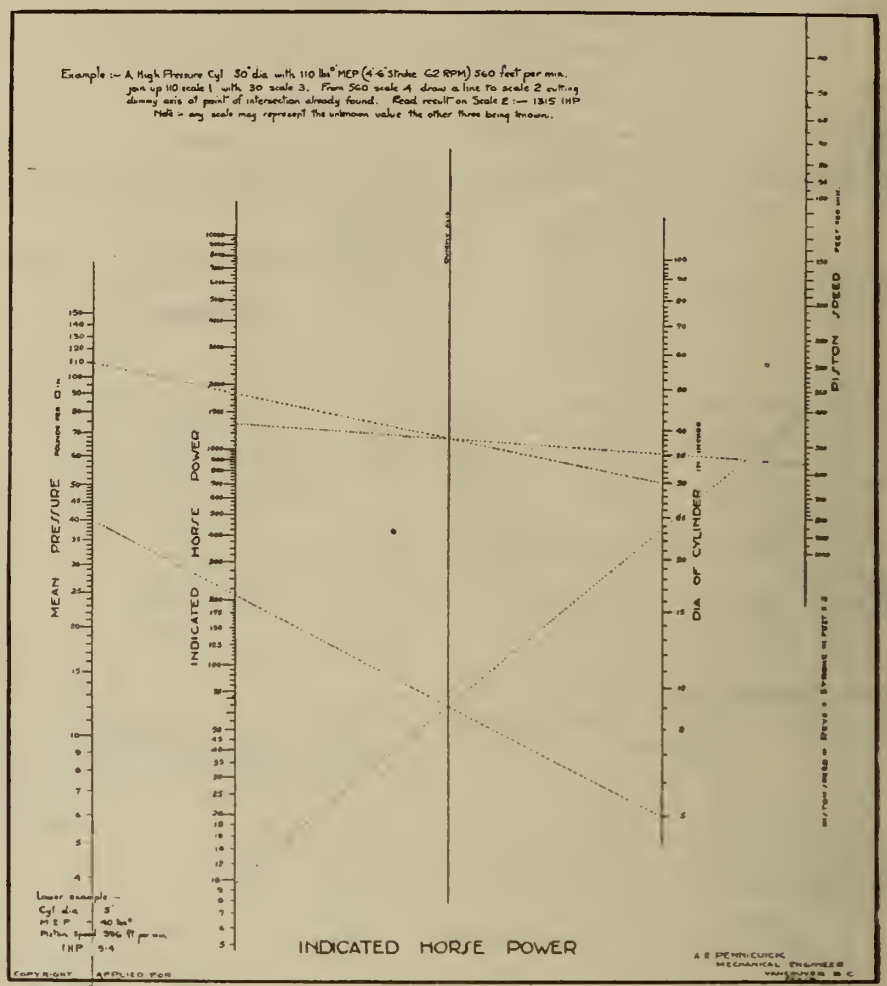
The point on the dummy axis where this line cuts should be indicated with a mark or held with a needle point, and with the straight edge against the needle point swing round until the edge lies on the point 560 feet per min.

The required value may then be read off on the I. P. H. scale 1315 I. P. H.

The lower example has the following values: Cylinder diameter 5; M. E. P. 40; Piston speed 396; I. H. P. 94.

It will be seen that any one of the four values may be the unknown one and that by always cutting the two lines at the same point of intersection on the dummy axis the unknown value can be found.

The notation of the scales should always be the same that is Scale 1 should always join up with Scale 3 and Scale 2 always with Scale 4.



WHEN IT DOES NOT PAY TO RISE TOO FAR

It is irksome not to advance rapidly. It tries one's patience. It makes one sometimes feel discouraged. But the events of the last eighteen months have brought home to many that it is dangerous to rise too far, especially in abnormal times. What has happened in a great many concerns is this: During the boom period promotions were made pretty rapidly. Things moved so quickly and money was being made so easily that promotions and salary increases were not always scrutinized with care.

Then disaster came. Boards of directors ordered drastic retrenchment. In many instances outside experts were called in to recommend reorganization of forces. Their investigations revealed that certain men were drawing big salaries for doing comparatively little work and that these men often were not of calibre warranting the salaries received. When heads began to fall, the heads of such men were the first to drop, In a great many cases, their places were taken by assistants or others who had not basked in the favor of any higher-ups and who were doing a lot of work for relatively little money.

If a list could be compiled of the dismissals during the last year of men drawing salaries of from $10,000 to $50,000 a year, it would create a tremendius sensation.

During this same period not a few able, industrious, conscientious fellows have moved upwards to fill the places of those who rose too rapidly and too far. The law of compensation may often seem to us to operate heartbreakingly slowly, but it does operate. It is safer to be paid less than one is worth than more than one is worth. That's a thought worth keeping in mind.—Forbes Magazine.

Official announcement is made that work on the new hotel at the corner of Richmond and Fullerton streets, London, Ontario, is to begin at once. The hotel will have three hundred rooms and is to cost about $1,500,000.

The City of Guelph is preparing to purchase some equipment for the Civic Water Works plant in connection with the decision to supplement the present steam equipment with that of electrically driven centrifugal pumps. It has been definitely decided to purchase one three million gallon electrically driven centrifugal pump, and one three million gallon electrically driven booster pump, as an auxiliary, two three million gallon gasoline or Diesel driven units will be purchased. It has not yet been decided whether these will be served by gasoline or Diesel engines but it is expected that a decision will be reached shortly.

Alignment Chart for Water and Brake Horse Power

By A. E. Pennicuick

The illustration Fig. 2 shows a Chart drawn up for the purpose of finding quickly the approximate Water Horse Power and Brake Horse Power required or perhaps the head or capacity of a pumping unit.

An example will illustrate the proceddure in finding the required value.

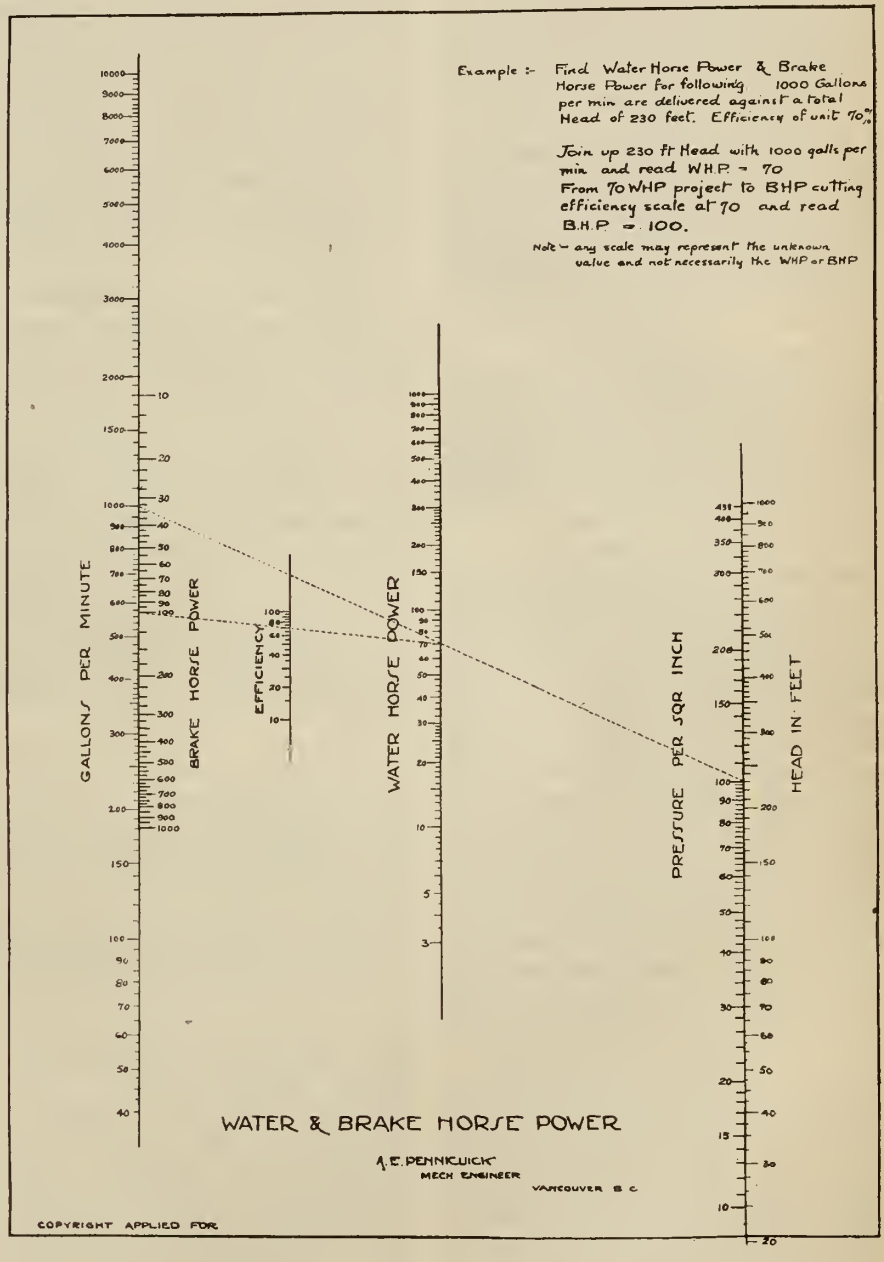
It is required to deliver 1,000 gallons per minute to a total head of 230 feet allowing 70 per cent. efficiency of unit. Find the W. H. P. and the B. H. P. required.

Join up point 1,000 on gallons per min. scale with point 230 feet on head scale and read on W. H. P. scale 70 Water Horse Power.

With straight edge lying on point 70 W. H. P. project across to Brake Horse Power scale cutting the efficiency li- at 70 and read required value 100 B. H. P.

The unknown value may in turn be the gallons per min. or the head and by reversing the above method of procedure these values may be found.

The scale showing pressure per square inch oppposite to the head will be found useful in converting head into pressure values and vice versa.


Example :- Find Water Horse Power & Brake Horse Power for following 1000 Gallons per min are delivered against a total Head of 230 feet. Efficiency of unit 70%
Join up 230 ft Head with 1000 galls per min and read WHP = 70
From 70 WHP project to BHP cutting efficiency scale at 70 and read B.H.P = 100.
Note - any scale may represent the unknown value and not necessarily the WHP or BHP
GALLONS PER MINUTE
BRAKE HORSE POWER
EFFICIENCY
WATER HORSE POWER
PRESSURE PER SQR INCH
HEAD IN FEET
WATER & BRAKE HORSE POWER
A.E. PENNICUICK
MECH ENGINEER
VANCOUVER B.C.
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TRACK TORPEDO

The old type of track torpedo which has served its very useful purpose for many years, has been officially superseded by a torpedo of radically new design, on all lines of the Canadian Pacific Railway. This new type is called the "Meteor." A more reliable method of attaching this torpedo to the tracks, than the soft metal bands, is used. It is fastened by means of two spring rail clips made of tempered steel or spring brass, this gripping the rail head firmly, and at the same time being promptly applied. Furthermore, assurance has been made trebly sure. The new torpedo appeals to three senses instead of one, not only hearing, but seeing and smelling. It not only produces a loud report on detonation, but simultaneously a brillant flash and pungent smell.

It is completely waterproof, will stand any atmospheric conditions of heat, moisture and frost. It has been subjected to one hundred hours immersion, and one hour in moist steam at 120 deg. Fahr. without deterioration, and has been used where the temperature was many degrees below zero with complete success. Special tests have been carried out to ascertain its holding power when placed in position on the rail, and for flying particles likely to cause injury to bystanders. These have all been carried out with satisfactory results.

VAPOR ACCUMULATOR

An invention which should be of great interest to every industry with varying steam demands, breweries, sugar refineries, chemical pulp and paper mills, creameries, etc., is the Vapor Accumulator, patented in some thirty different countries, among which Canada and the U. S. A.

The principle of the invention is to equalize the varying requirements for steam in an industrial plant by storing the heat in water when excess steam is being produced, and giving off this steam when it is needed, thus practically making the boiler plant independent of the variations in the steam consumption.

As, under these conditions, the firing can be carried on evenly, and without either forcing or holding back, and as the load, consequently, can be kept comparatively constant, the fuel can be utilized very effectively.

The Brown Corporation, La Tuque, Que., have an installation of a Vapor Accumulator in operation in connection with their sulphate pulp mill, since some six to eight months.

The Vapor Acumulator consists principally of a large tank containing water, in which the excess steam produced in the boiler house during times of light steam demand is stored, while the tank gives off the steam thus stored, when it is needed.

The installation is said to be working very satisfactorily, affecting a considerable saving in fuel.

The Theory of Lubrication*

By William F. Parish

A lubricant has two functions to perform: First, keeping the surfaces apart; second, conveying from such surfaces heat that is caused by friction. Friction comes from two sources: First, abrasion or the metal striking due to the use of too thin an oil, which is called solid friction; and second, the oil working on itself, which is called fluid or internal friction. The art of lubrication is based on the balancing of these factors so as to secure for every possible classification of machinery a lubricant that will keep the surfaces apart at working temperatures and at the same time cause the least internal or fluid friction.

A difference can be noticed in the operation of machinery when lubricated with materials so heavy that they produce internal friction and when lubricated with materials that are properly balanced so that there is no abrasive friction and the oil operates with a minimum of fluid friction.

Loss Due To Resistance Of Oil Films

Loss of power when using a heavy oil is due to the resistance of the oil films. The oil between the surfaces can be considered as a series of films. That which is next to the fixed bearing will drag slowly against the fixed surface of the lining. The drag is related to the adhesive power of the oil; oil that is high in adhesive qualities will drag slower than oil that is not so adhesive. The film that is next to the shaft, at whatever speed it revolves, will be dragging at nearly the surface speed of the shaft, affected also by the power of adhesion—the greater the adhesion the faster it will drag. The layers in between these two films revolve at different speeds; one revolving at comparatively high speed, the other almost still. The effect of this working of the oil films is transferred to heat. The greater the resistance in the oil due to its cohesion or power of clinging together between the surfaces of the various films, naturally the greater the heat developed. This heat is radiated through the bearing and through the air. The conductivity of the metal, therefore, has much to do with the temperature at which the oil is finally maintained.

Every oil requires a certain amount of time)generally from 45 minutes to 1½ hours) to work up to a temperature above that of the room, which is maintained for the rest of the day. The oil, when cold, may be of the proper body to keep the surfaces apart and operate efficiently. However, the heat generated within the oil itself through fluid friction due to constant operation may be sufficient to lower the viscosity or reduce the body of the oil to a point where abrasion takes place. The heat of abrasion will still further increase the temperature of the oil and reduce its effectiveness as an agent for keeping the surfaces apart. It is necessary, therefore, to use oil that will maintain the prescribed body at working temperatures and under the highest surrounding temperatures to which the machinery is subjected. This makes it necessary to use an oil that, when cold, has too much body for effective lubrication, but this oil will generate enough heat in starting to reduce its body so that the balance is obtained.

Oil Requirements of Bearings

Thin bearings that radiate heat quickly require a different oil from bearings designed so that the heat is radiated slowly, allowing the oil to work at higher temperatures. In the latter case, which is generally the rule with the heavier bearings, an oil of considerably greater viscosity must be used originally to compensate for the difference of radiation. The power required to start the shafting when the oil is cold is always excessive, and the power is reduced as the oil heats up. When the heat generated equals the heat radiated, the body of the oil becomes steady and the power required for the operation is likewise steady.

In the case of spindles or light high-speed machinery sensitive to lubrication, the effects of improved lubrication are always denoted by three conditions: First, reduction in power; second, reduction in temperature; third, increase in speed.

The cotton spindle, which for certain classes of work revolves at from 800 to 12 000 r.p.m. is the lightest type of general machinery to lubricate. The oil made for the cotton spindles is the lightest-bodied oil made for lubricating purposes. The basic rules of lubrication which are worked out and studied in connection with the many hundreds of tests on these spinning frames, are applicable to every classification of machinery. Reduction in temperature through change of lubricant is always associated with reduction in resistance to the turning of machinery, even though at all times the speed is not affected. In general, in textile-mill lubrication-engineering practice, reduction in resistance in the spindle bases, with consequent increase of speed of the spindles due to the lessened band slippage and reduction in resistance of all the other machinery, will generally show in an actual increase in speed and production of the entire mill. In extreme cases with overloaded engines the lightening up of the mill through reduction of the frictional loss will result in an increased number of revolutions per minute of the engine and will allow of operating at 10 to 15 per cent less power. Increased production as high as 1½ per cent has been secured with reductions of 10 to 12 per cent in the power necessary to drive the mill.

In straight mechanical-engineering practice, increasing the speed of the mill to secure greater productiveness must always be accompanied by forced increase of power. Forcing machines to operate at higher speed by changing the size of the pulleys or even by putting dressing on belts so that they will have greater traction always places an extra load on the main engine. In lubrication engineering, however, which is a science of reducing friction losses, the savings are all made up of reductions of losses of friction and resistance and of the loss or slippage in belt transmission system.

Illustrating an extreme case of friction losses, a test on a 10,000-hp. reversing rolling-mill engine is cited. It is only necessary to say here that lubrication of this large unit as found was representative of the conditions which existed in steel-mill practice some years ago and, unfortunately, is sometimes found today. Changing the manner and method of lubrication made it possible to reduce the friction load at 88 r.p.m. from 1,239.5 i.hp. to 249.95 i.hp., a reduction of practically 80 per cent.

Analyses of Tests

Analyzing the tests containing these figures showed that the original method of lubricating this unit gave results that approached the laws of solid friction; that is, that while the surfaces apparently were not actually in contact, there was interspersed between them material of such a heavy nature that the resistance was so great as to approach the resistance of solid masses working upon themselves. As soon as the lubrication was changed, the condition approached that which is given by consideration of the laws of fluid friction. It is, of course impossible to secure in a unit of this kind either purely solid friction or perfect fluid friction. This test, however, indicates quite clearly a possible near approach to each of these conditions and represents what takes place in an extreme degree when lubricants are used that are entirely unsuited. In this particular case the great resistance in the engine itself was reflected in the difficulty of handling the reversing levers. The reversing was done by auxiliary steam cylinders as well as by hand levers. It required a full opening of the throttle to the auxiliary cylinder and all the power possible for one man to exert on the hand levers. After the change in lubrication was made, only partial opening of the throttle to the auxiliary cylinders was necessary, and the men would operate the hand levers with ease. Further, it was observed by the operators that the speed of the entire mill was increased. The engine was handled quickly on the reverse and would get up speed in a fraction of the time that was formerly required.

In this case all of the various rules shown in lubrication of spindles applied,

* Excerpts from paper presented at first annual convention of the American Society of Lubrication Engineers.

as far as general lubrication was concerned. The lubrication of the steam cylinders, however, was handled through a new set of factors. The change which was made and the results obtained reducing the load of this part of the unit were due to securing a better distribution of the lubricant through having it properly atomized and carried with the steam where it could be spread upon all the surfaces with which the steam came in contact, where formerly large quantities of a heavy lubricant not suited for the work were forced on the surfaces some seconds after the machine was placed in motion and this oil would be worked back and forth on these surfaces in that form, resulting in much fluid friction. The oil fed in this manner would not spread to the upper part of the cylinders, which were undoubtedly, in consequence, operating metal-to-metal. Of the total 990 hp. saved in this unit when it was turned 88 r.p.m., at least 50 per cent would easily be charged to cylinder and valve lubrication, the remainder to the main bearings, pins, guides and connections.

THE MADE IN GALT EXPOSITION

A very interesting exhibition of made in Galt products, was held in that city from November 12 to 19th. The exhibition was held in the curling and skating rinks, and was largely attended. The exhibits of interest to the power house fraternity were as follows:

Goldie & McCulloch Co.—Rees Roturbo Pumps, showing details of construction; a vertical enclosed, forced lubrication steam engine. A 200 H. P. Wait steam turbine, 3600 revolutions per minute with steam presure of 175 lbs. per sq. inch; photo of engine No. 1 installed 62 years ago and still running in the plant of Chas. Barber & Son, Meaford; boiler heads with gauge equipment, and a display of safety vault doors.

An effective feature of the display was the illumination of a large Rees Roturbo transparency sign by means of violet lights behind a sheet of water falling into a tank from a horizontal pipe about eight feet above the floor. The steady flow of water was supplied by a small Roturbo pump, with a 3 inch intake, attached to a five horse power motor. The pump at 1400 revolutions per minute, had a capacity of 200 gallons with 60 foot head, and demonstrated the ability of Roturbo pumps, even in the smaller sizes, for shop circulation systems, or the general range of purposes. The pump stood on a light wooden frame without vibration or oscillation and apparently motionless although in operation.

Sheldon's Systems:—Keith fans, cupola fans, air purifiers and oil separators, ventilating, heating, exhausting and drying equipment. A model factory building with equipment in position was used in demonstrating a heating and ventilatng. stallation in operation.

The Sturtevant Co. of Canada:—Planing mill exhausters, multivane electric exhaust fans, auto-force ventilators, ventilating sets, gas boosters, electric vacuum cleaners, cupola forge blowers and other ventilating and exhaust equipment.

EMERGENCY OPERATION OF SELF COOLED TRANSFORMERS

On account of self cooled transformers being designed on an ambient temperature of 40 deg. C., advantage of the full rating of the transformer may not be obtained where temperatures are above this point. Such a case happened in a sub-station of the Southern California Edison Company, so that artificial cooling was necessary. To meet the conditions, air ducts were installed around the base of the 5000 kv-a, single phase maximum rated, self cooled radiator type transformer, so arranged with openings placed between the radiators to direct the flow of air supplied by a motor driven blower.

With this method of artificial cooling, these maximum rated transformers will carry 25 per cent. overload continuously with the same winding temperatures as at full load without artificial circulation of air.

The transformers provided with a hot spot temperature indicator, an oil expansion tank and a high voltage tap changer, the latter operated by a hand wheel in a convenient position above the transformer cover.

The plant of Scottish Fertilizers Ltd., one of Welland's new industries, is rapidly nearing completion, and will probably be ready to commence production early in the new year. The plant was designed by British Chemical Engineers and embodies some of the best ideas of British and American practice.

The erection of a central heating plant for the general hospital is being considered by the city of Guelph. Work will be proceeded with as soon as they can raise the sum of $30,000, this being the cost of the equipment they have in mind. Some action will have to be adopted shortly for the present equipment is said to be both insufficient and inefficient.

A fair amount of business is on hand at the Port Arthur Shipbuilding Company Yards, that ensures active operation during the winter months. Extensive repairs will be made to the steamer Huronic, an American vessel that was bought by the Matthews Steamship Co., of Toronto, and which is to be converted into a Canadian vessel. Two large boilers are to be built for the western market. The company plans to construct twenty low-pressure heater. boilers of various sizes during the winter. Hopes are entertained that a contract for the construction of a large bulk freighter for lake service will be placed in the near future.

Mr. Waterhouse, general manager of the Engineering and Machine Works of Canada, St. Catharines, says that his concern are very optimistic regarding business conditions for the coming year.

Georgetown, Ontario, has awarded the contract for the installation of a waterworks pumping plant to Goldie and McCulloch, Galt, the cost to be $9,383.

We are in receipt of an inquiry as to who manufactures "Killametal." This is evidently a compound for the purpose of nullifying the chemical reaction of metals. Any information as regards the name of the manufacturer, or where this product can be secured, will be welcomed by the Editor.

Some figures obtained from the November bulletin of the department of development in connection with the Canadian Pacific Railway show that Canada has risen to second place among the wheat growing countries of the world.

ANNOUNCEMENTS

The Combustion Engineering Corporation announce the opening of two branch offices one in Charlotte, N.C., and one in Seattle, Washington. The Charlotte office is under the direction of Mr. T. E. Nott and the Seattle branch under the management of the Fryer-Barker Co.

The Betson Plastic Fire Brick Company of Rome, New York, announce a change in their selling arrangements in the Central Western States. Frank L. Page of Chicago, Illinois is no longer connected with them in any way whatever, and the Company will again sell Betson Plastic Fire Brick and High Heat Cement direct to the user through its various branch offices and its branch office salesmen.

The Chicago office will be in charge of Mr. C. Z. Dillenbeck, 1514 Kimball Building, Chicago, Illinois. L. S. Shaw & Company, main office 5716 Euclid Avenue, Cleveland, Ohio, with branch offices in Detroit, Michigan and elsewhere will again act as general agents and distributors for the states of Michigan, Ohio, Indiana and Kentucky.

Substantial stocks of their various products will be carried in principal cities to facilitate prompt delivery.

The Betson Plastic Fire Brick Company are the pioneers and originators of the idea of applying an unbaked fire brick in a moist plastic condition, thus making possible and practicable one piece furnace linings, including side walls and arches, also the forming in place boiler baffles at the desired angles to secure tapering passes. No special forms, tools or skill are required in the use of their material.

They issue some very interesting booklets that ought to be in the hands of every owner owning a power plant end every engineer. These booklets will be mailed free upon request.

Member of the Audit Bureau of Circulation

POWER HOUSE

NOVEMBER 5th, 1921.

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

T. H. FENNER - - - - Editor
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Didn't Know It Was Loaded

EVERYONE is familiar with, and has smiled in a superior manner at the man who gets shot with a gun that he didn't know was loaded. That there are other things than guns that can contain a deadly charge has been the experience of a man in Ontario during the last few days. His experience has been a terrible one, in that he has lost his right hand, and as the man was an expert mechanic, the meaning of such a loss can be appreciated by all those who work with their hands.

This man was engaged in some repairs on a pump, and during the course of his work, had occasion to remove a nut, perhaps the piston nut itself, or one of the follower bolts. In any case, he had the rod and piston out of the pump, and in order to make the work a little easier, or to make sure of not breaking anything, he took it over to a small blacksmith's forge fire, and put the piston in the fire, holding the rod by the other end. He had only had it there a few seconds, when an explosion occurred, and the piston was torn violently asunder, one piece travelling up the rod in a straight line, and in its course cutting off the hand of the man holding it.

The cause of the accident, of course, was that water had in some manner got into the piston, very probably between the rod and the bore of the piston, or through a porous casting into the piston itself. It's admittance and accumulation would be a slow process, but its raising to boiling point and subsequently to steam was a process of seconds only at the high temperature and comparatively large quantity of heat available in the forge. Once more that terrible force, the force of molecular expansion was called into being, and the frail metal was shattered and with it a man's hand. We have called attention before in these columns to the energy contained in even small quantities of water which have been raised to high temperatures and pressures, and here is another melancholy and painful example to give warning. Never put anything in a fire to heat unless you are morally sure that there can be no water contained in it, and if there is, that there is ample room for the vapor to find its way out as fast as it is formed. Of course, we know that such an accident is not frequent, and it is to be hoped will never become so, but the danger is always there, and no one has a right to take a chance. If he does not know of the danger, he cannot be blamed, but every man who is engaged on work around engines and boiler rooms should know these things, or have them drawn to his attention by the man who does.

Charles Mosley Passes

DEATH has once more visited the Board of Examiners of Stationary Engineers at Spadina Crescent. This time the reaper has gathered in Charles Mosley, the oldest member of the board. The news did not come as a surprise to his many friends, for it has been realised for a long time that Mr. Mosley was in a very delicate state of health. He was sixty-one years of age at the time of his death, and for forty of those years he had resided in Canada. Like his late colleague, Mr. W. C. McGhie, who pre-deceased him but a short time ago, he was widely known and widely respected by all the engineering fraternity in Ontario, and all others whose business brought them into contact with him. He enjoyed the enviable reputation among his fellow men of being absolutely straight and above board, and of having always at heart the interests of his fellow engineers. He was closely connected with the movement for bettering the conditions of engineers in the Province of Ontario, and with the movement for the obtaining of a graded certificate. He was a well known figure at the conventions of the Canadian Association of Stationary Engineers, of which he was a past president. He was also the first worthy chief of the Universal Craftsman's Council of Engineers, when that organization was formed in Canada. He was also a past master of York Lodge, A.F. and A.M., a member of Canada Lodge, I.O.O.F., and a member for thirty years of Warwick Lodge, Sons of England. He was born in Kent, and thus kept up his affiliation with the old land.

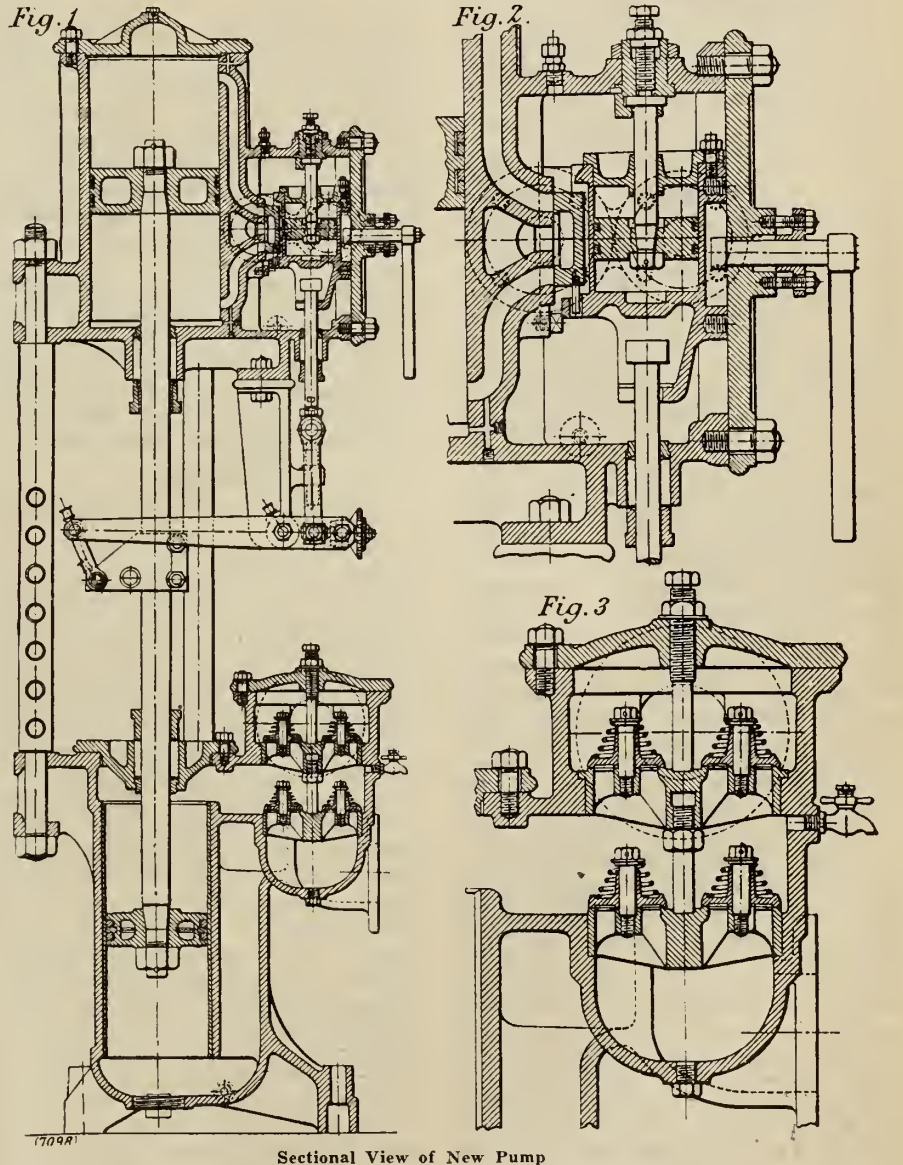
Mr. Mosley had a long and active life as a stationary engineer before joining the Board of Examiners, among the positions held being that of chief engineer for the town of North Toronto, and chief engineer of the Toronto Street Railway plant. His son, who survives him, is also an engineer, being chief engineer of the central heating plant of the University of Toronto. Mr. Mosley is also survived by his wife. His cheerful and kindly presence will be missed from the various circles which knew him, and by his brother engineers in particular.

Progress in New Equipment

DIRECT ACTING BOILER FEED PUMPS

An example of the latest pattern of "Anthony" boiler feed-pump is illustrated in the annexed figures. This type of direct-acting pump, which is built by gineers of Walton-on-the-Naze, P. and Messrs. Robert Warner and Co. (En-O. House, 14-16, Cockspur-street, London, S. W. 1, has proved very successful during recent years, and was supplied extensively for naval services during the war. The steam end of the pump embodies special features which, it is claimed, add to the volumetric efficiency of the unit and enable it to be run at high speeds without danger. Great attention has also been paid to securing convenience of overhaul, and the special steam distribution unit can be removed, examined and replaced in from 3 to 7 minutes depending on the size of the plant. The outstanding feature of the pump is that the main steam valve is moved mechanically for part of its stroke, the motion being completed by steam. This combination arrangement ensures that the piston—and consequently the pump bucket—is brought to rest gradually, and without shock, at each end of the stroke, allowing the pump valves to close firmly on their seats and assisting volumetric efficiency. The valve gear a.so ensures the pump being entirely free from the danger of the piston striking the cylinder covers owing to the pump losing water from any cause and racing. This feature makes the "Anthony" pump very suitable for fire purposes for which it may be necessary to run at a high speed.

The general lay-out of the pump will be clearly followed from Fig. 1. The steam cylinder is carried at the top of mild-steel turned columns, the back column beisg arranged with a series of holes to form fulcrums for a bar when it is desired to move the pump by hand when steam is off. The steam cylinder and valve chest are a single casting, which is of simple form, so that the chest can be lagged as well as the cylinder. The piston rod is of high tensile steel, and is connected at the crosshead to the cold-rolled manganese-bronze pump rod. The pump is of the double-acting type, and the working cylinder is fitted with a renewable gun-metal liner. The water piston is of gun-metal, and is fitted with ebonite, or woodite, packing rings. The valves are of gun-metal of the solid disc type, and are well shown in the enlargement of the valve chest given in Fig. 3.



Sectional View of New Pump

The steam distribution unit which is the special feature of the pump, is shown to an enlarged scale in Fig. 2. As will be seen, the main steam cylinder has a three-ported valve face on which an ordinary slide valve works. Behind this valve, but quite independent from it, there is a small steam cylinder, which is very clearly to be seen in Fig. 3. The piston of this cylinder is fixed, the cylinder itself moving and working on faces on either side of the main valve face. A rod with an enlarged end projects through a gland on the lower side of the valve face. This rod, as shown in Fig. 1, is attached by lever gear to the main piston rod, a fulcrum being provided on a bracket hanging from the main casting. The rise and fall of the main piston rod transmits a reciprocating motion to this rod. To follow out the operation of the gear a condition may be assumed when steam is being admitted to the bottom side of the main piston, and its top side is open to exhaust. Under these circumstances the main piston would, of course, be traveling upwards and the link motion would draw the valve chest rod downwards. As will be seen from Figs. 1 and 2, there is at first a certain amount of lost motion, but when the enlarged end of the rod engages with the bridle at the bottom end of the small cylinder

casting it will pull the cylinder downwards and with it the slide valve, the valve being engaged by a projection on the upper part of the cylinder.

There are two small ports arranged on either side of the slide valve and two corresponding small ports in the small cylinder. These ports are not shown in the figures. At the time when the main piston has nearly completed its stroke, and when the lower main steam port has been closed by the slide valve the small cylinder is pulled down into such a position that small port on one side has passed over edge of main port face, and at the same moment the small port in the other side is put in direct communication with the exhaust port, the result being that live steam is admitted to the lower end of the small cylinder. This cylinder consequently shoots over the remaining part of the travel and carries the main slide valve with it. This action opens the upper main steam port to live steam and puts the lower main port to exhaust. The same sequence of operations is then repeated, the small cylinder being pushed up instead of pulled down. As will be seen from Figs. 1 and 2, auxiliary ports are formed in the main cylinder at the very end of the travel of the piston. Steam is first admitted through these ports when piston commences its travel from either end of the cylinder. The steam connection through these ports also serves to cushion the piston at each end of its travel.

It will be clear that this gear combines advantages of a positive mechanically-driven steam-distributing arrangement allowing of a predetermined and definite cut-off as in a crank-driven pump, and at the same time by employing steam control at the end of the stroke, allows the elasticity necessary in a direct-acting arrangement. The valve gear embodying a controllable cut-off allows of economical working, and losses in the valve cylinder are cut down owing to the fact that it is always completely steam jacketed. We have already referred to the question of convenience of overhaul, and in this connection should point out that the valve unit may be completely removed by taking off the valve chest cover. Both the fixed piston rod of the small cylinder and the moving valve rod fit into forked bridles so that the unit can be drawn out sideways as soon as the cover is removed.—"Engineering."

The Weeks Engineering Corporation, an American organization, has decided to establish a plant at Welland, Ontario. The principal product of the new works will be boiler plates. The company is taking over the Welland Machine and Foundry Company and will install machinery almost immediately. Additional buildings will be erected next spring and the entire site consisting of four acres, provides room for expansion. It is estimated that between seventy-five and one hundred men will be employed in the boiler tube plant.

AN ELECTRIC SOOT RECORDER

Information was published recently regarding an interesting instrument for recording the amount of smoke suspended in the air from hour to hour. In this machine a fixed quantity of air was drawn through a piece of wet filter paper which was stained to a greater or lesser degree by the impurities in the air. Another instrument has been devised in Britain for a similar purpose, and it operates on an electrical principle. It consists of a covered dish containing a small quantity of electrified water over which the air to be tested is passed. By proper adjustment of the rate of flow of the air all the acids in the air are dissolved in the water and the solid particles fall into it. The proportion of acid can be readily estimated by chemical means as the solid impurities make themselves known by changes in the electrical resistance of the water. The advantage of this appliance is that it indicates the amount of acid in the air as well as the amount of smoke. This is an important point as the proportion of acid has a great deal to do with the harmful effect of air upon stone and other structures.

A MUTABLE ELECTRIC SIGN

Dwellers in cities have become quite accustomed to the large electric signs which flash out a variety of messages. They have little idea of the complicated mechanism which is required to provide a series of messages, or the ingenuity involved in their design. The latest type which has been evolved by a British inventor after more than ten years' experiment constitutes a remarkable advance on existing types. Letters, words, sentences, and designs are produced by pneumatic power from movable spheres, each six inches in diameter. By day the spheres twinkle white or in contrasting colors as fancy may dictate, and at night they are automatically illuminated electrically. A sign may be withdrawn and another inserted in its place wthout stopping the machinery; in fact a whole speech could be expressed line by line, and thus delivered more effectively than by megaphone. There is no end to the variety of letters and words which may be made to appear on this sign. The mechanism depends on a simple arrangement of perforated sheets.

A cable from London, England, states that in some things Canada can beat Germany at her own game of cheap production. According to the Mercantile Guardian, after going the rounds of the world's markets, buyers for the first time in many months find Canadian Aluminum the cheapest, selling at 14½ pence per pound, while the German product, despite the deprecation of the mark, is 2 pence dearer. The Canadian product, which is often called American, because it is shipped from New York, is said to be of exceptional quality.

PROMPT SERVICE IN PIPE SHIPMENT

What may be considered as a record in the fabrication and shipment of riveted steel pipe was made in the extension of the Keele Street sewer at Sunnyside, Toronto, by the Dominion Bridge Company recently. The extension consisted of three pipes, each 560 feet long, two of these 90" in diameter and the third one 60" in diameter. The total weight of the contract was 612,000 lbs. The inland ends of three pipes are in the form of thimbles built into a concrete wall. The outer ends pass through the crib work which has been put in place as a retainer for the new "Marginal Way." The pipes are not quite straight throughout their length, they have each two elbows, but the angle of deflection at each of these elbows is less than 3 degrees.

The three thimbles were required in advance so that they could be set in the concrete, but the shipment of the balance—practically the whole of all three pipes—was called for to be made at one time and not later than November 1st, under penalty. The erection to be performed by the Toronto Harbour Commissioners who contemplated the laying of the whole pipe on trestles and sinking it altogether.

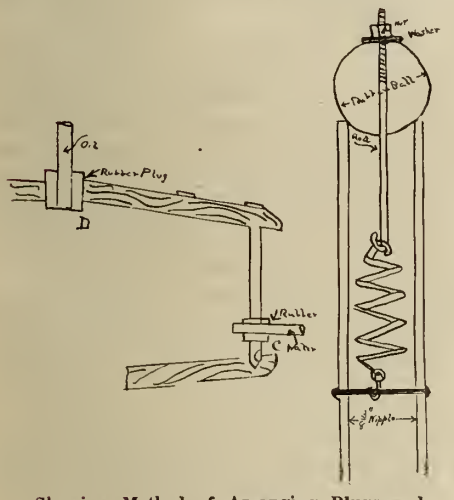
The contract was awarded to the first mentioned company, on September 30th. On account of the character of the work, they decided to fabricate the pipes at their Lachine plant, where their boiler department is equipped for this work. The specification called for boiler quality material. The orders for the material were mailed on October 1st, the day after the awarding of the contract. Prints of the shop drawings were mailed for approval on October 4th, four days after the date of the contract. The material was rolled promptly and was received at the Lachine plant between the 17th and 20th of October. The thimbles were shipped within the stipulated time. The final shipment of pipe was made from Lachine on October 29th and consisted of 29 carloads, each car containing one or two lengths of pipe about 40 feet long. The ends of each section were fitted with flange angles bent to a circle and welded, their outstanding legs being drilled for connecting bolts. This final shipment actually arrived in Toronto at twenty minutes past three on the afternoon of October 30th, two days earlier than the date on which the pipe was called for to be shipped from Lachine.

The Ontario Agricultural College, Guelph, Ont., is to have two new buildings erected to be ready for occupancy in a year and a half. Building operations have already commenced. They will consist of a Dairy and a Veterinary building which will, when completed be the whole to cost in the neighborhood of $150,000. Up to date, motor driven machinery will be installed in the dairy building which will, when competed be one of the finest equipped institutions of its kind in the country. The power plant will consist in the main of two 75 h.p., h.r.t. boilers.

The Operators' Point of View

EMPTYING OIL BARRELS

Several letters have appeared in the correspondence section of Power House in reference to emptying oil barrels with air pressure. Very many engineers, especially in small plants, have no supply of compressed air, where such is the case water can be used. In all cases the water pipe should be several sizes smaller than the oil pipe. A ¼ inch water pipe, and a ¾ or 1 inch oil outlet pipe will be O. K. When this plan is used there is absolutely no danger of a burst barrel when emptying light oils, such as engine or dynamo oil. Heavy machine, lard or cylinder oils should be



Showing Method of Arranging Plugs and Safety Valve

left in a warm location until the oil thins before trying to empty the barrel by either air pressure or water pressure.

Very few oil barrels will leak to any extent under a pressure as high as 5 pounds. At one time I emptied many barrels of oil to an overhead tank, 8 feet high, using compressed air, using rubber plugs at the air inlet and oil outlet and had no burst barrels.

The sketch Fig. 1 shows the water emptying plan. Of course it is necessary to watch the emptying process, otherwise water will be carried to the oil tank when the barrel is emptied of oil.

If the user is nervous, he can easily make a safety valve which he can install in a tee between B. and C. An enlarged sketch of the valve is shown in Fig. 2.

BACK PRESSURE HEATING

Editor,
Power House

In your issue of October 20th you have (in my humble estimation) a good article on "Economy of Working with Back Pressure." We use these contributions in coaching along our night classes, but notice some apparent errors, typographical I guess is the word. For instance in the 2nd column 2nd line it states "1118.7 heat units still available" and in 3rd column near bottom "exhausted at a temperature of 21 degrees."

While you may have it in mind to keep us alive and on the job watching for the sins of compositors and proof-readers you know yourself, Mr. Editor, the layman finds enough puzzling inconsistencies in the measurement of temperature, heat and work to thresh out among the boys, without watching his step for "Latent" pitfalls in the magazines.

A. Ellis
Union Bay, B. C.

We apologise to Mr. Ellis and all other readers for these which are of course typographical, as he surmises. While every effort is made to prevent these errors occurring, a proof reader sometimes slips up, and it is probably too late by the time the editor sees it to make a correction. We are pleased to note that Mr. Ellis can find such an excellent use for Power House, and also that he possesses a sense of humor which is certainly not "latent."—Editor.

Why not a Dominion Wide Certificate

The Editor:

Your editorial in reference to this question is interesting, in that it raises a question many times suggested by new comers to British Columbia. The first thing an engineer is up against when coming from the other side of the Rockies, is an examination.

Permits, or temporary certificates are very seldom granted, and the new arrival usually feels very much aggrieved to think that his certificate is not as good as the one demanded of him.

To sit for the examination, he must first produce testimonials, covering the qualifying time, and these, in many cases, he has lost, or cannot find the firms who employed him. So he rampages around, and expresses his wrath at the inspectors, who by the way, are also the examiners, here, for preventing him from obtaining a job; which brings us to a point you have raised about men outside a certain province having been deliberately refused the opportunity to even sit for the examination. Mr. Editor, it would be fair to mention which Province, as this statement casts a reflection on all the Provinces.

As an Inspector of Boilers for some ten years, I know that no such ridiculous thing ever occured, or was ever hinted at, in British Columbia.

Regarding an earlier statement, "Supposing a local man in town, well known to the examiners, and most of the engineers, and popular with both, is after a certain position; opposed to him is a man from another Province, whose ability to land the job depends only upon his obtaining the local certificate. How much chance has he to obtain this certificate?"

You imply by this, that the examiners would be liable to prevent one man obtaining his certificate, while another, who was better known locally, was allowed to pass his examination.

British Columbia has probably the strictest examinations and examiners in Canada, and there is no inspector that I am aware of, who would be so low as to countenance anything like this. I know of many personal instances where men have been sent to positions within a few days of the examination, by the Inspectors themselves, after having been in British Columbia only a couple of weeks, although it is most unusual for them to know when a plant requires men, as they do not run an employment office in the Boiler Inspectors Dept., here, and do not encourage firms to ring them up for men. There are other means of obtaining men available.

Why suggest generalities that reflect upon a large body of trained neutral and honest men, unless you can lay upon specific instances. I venture to say, that any Inspector in this Province, who did the things you suggested, would soon be advised to resign. A great many of these kind of complaints have no foundation, but a grievance against some examiner who failed to pass a man not up to the standard, or who may not have had testimonials, and was unable to get them, and I might just mention here, that this Government will accept testimonials from any responsible person, who can certify as to the facts that a man operated a certain time; and surely any engineer, who is an engineer, must know some person in some place that can vouch for him.

The fact that a man carries a certificate in his pocket is not necessarily evidence that it is his.

There are a few points about an all Canadian certificate that require consideration. Further along you suggest only two grades. Here local conditions come in. We have four grades here, first, second, third and fourth; and special for logging, traction and creamery, etc.

The fourth class is limited to 75 H. P., but the holder can operate as assistant on a third class plant, and so on. A third can operate 375 Boiler H. P., and act as assistant to a second class, who upon non-condensing, can operate unlimited, and upon condensing, 750 H. P. The first is altogether unlimited. We had a fifth class at one time for loggers. This has been abandoned, and now there is a loggers special. Why? There is good reason for these things. A man who passed his examination in Ontario for operating with a second class certificate, and who had obtained his experience in a stationary boiler plant, would not only be a failure on a logging donkey for a long time, but a very serious menace to the men working with him. You may have seen photographs of the logging industry, and will readily conceive that it requires special knowledge. So a man cannot obtain this certificate unless he has had at least six months experience in a steam operated logging camp, and obtains a reference from his boss, that he considers him qualified. Then the Government will examine him as to his capabilities as an engineer.

Is there any Dominion wide examination which can ever cover this point? A man from Alberta, for instance, could never get this certificate until he had been in British Columbia at least six months. Can you compare logging in Ontario with logging in British Columbia? I do not know, but from what I have heard, I think not.

Why the lower grades? Such as third and fourth, simply because it would be impossible for many men to pass the higher grades. Would it not be a sort of discrimination—I think it would—to shut these men out of a livelihood, because of their inability to absorb a certain amount of necessary knowledge, and because they had not sufficient practical training?

The two class certificate means, in this Province, a lowering of the standard of Engineers examinations, and unless you concede this is necessary, and advisable, I do not see how you can bring it about. Even so, no process of elimination would do away with the special certificate mentioned, and others of the same calibre, where special knowldge is regarded as necessary; not so much from a safety point of harm to the boiler and engine or plant in general, but to the safety of the men working around the plant.

Turn the average first or second class stationary engineer loose on a steam shovel, and where does he get to. He may succeed in hurting someone or upsetting a car, or possibly his machine; at anyrate, his chances of success are poor without a reasonable amount of training of some kind previously.

In British Columbia, no fireman has to have a certficate unless he is the engineer as well. But no man can be alone in charge of a boiler plant unless he has a certificate applicable to that plant.

These conditions might well be reversed, and the British Columbia man go East, and he would be in exactly the same condition as his compatriot from the east. Both as regards to his ability for specific lines, and for his ability to get the work done quickly, safely and well.

The question of an examining board, you have brought up, and of the Dominion Government appointing Inspectors to watch the examiners. These Inspectors would most naturally be appointed, say one from each Province, and would more than likely reside in that particular Province, and so would only be an additional source of expense to the ratepayers at large.

Would a Dominion wide certificate make any difference to a man's chance of being examined without prejudice? If we grant, for instance, your assertion that discrimination might be shown a man because he had not been in a Province long enough to compete with an old timer. What difference would that make if he had to go up for examination, whether it is an all Canadian certificate or local. He would be in the same position as if he had to obtain the local certificate, anyway. He might have an even chance if he had already obtained the certificate in some other province, but not necessarily so.

This question you have opened up, Mr. Editor, is far too long to write about in one letter. The subject is far too broad and consequently will suggest it time enough for me to give some further views after others have expressed theirs.

In conclusion might I suggest that the experiences of the different Provinces with local conditions peculiar to themselves, is one factor which would be difficult to overcome with an all Canadian Certificate.

Yours very truly,
Percy A. Goepel.
Vancouver, B. C.

EDITOR POWER HOUSE

Having read the article in Nov. 5th issue of Power House re Dominion wide certificates for stationary engineers and I think it a fine idea and one that should be given very deep consideration as I can not see any reason why a man that is capable of handling a steam plant in one province should be barred from operating a plant of similar size in any other province of the Dominion. One cannot wonder much at a province that has a good standard of examinations for engineers not wanting men from Ontario as the last year or so has been such a huge joke that any person that had the price could get a certificate but since the coming of the graded certificates the standard of engineering in Ontario has been raised and is fast coming to the point where it rightly belongs and I hope that time will come when engineering in Ontario will be on a par with other provinces.

I just want to ask a question regarding the amendments to the Engineers' Act. Does it mean that a man who is in charge of a plant of over 600 B. H. P. must hold a first class certificate or does it mean any person wishing to take charge of a plant of over 600 B. H.P. must obtain a first class certificate?

Hoping I am not to bothersome, I am, yours truly,

Frank Moore,
Sarnia

The letter under this heading in the November 5th issue of Power House has brought forth so far two replies, one in agreement, and one which does not agree. These letters are both published in this issue, and some of the points brought up by Mr. Goepel will be answered here.

First of all, Mr. Goepel requests that the name of the Province wherein men were refused examination should be stated, as otherwise it is unfair to other provinces. That may be so, and perhaps it would have been as well not to mention that particular case, but we would inform Mr. Goepel that the inspector in question has been retired for some years now, and it would serve no good purpose to mention any names in connection with the case. We would be willing to furnish Mr. Goepel with the particulars for his private information if he should wish it.

As to inspectors, or examiners, being inclined to give the benefit of the doubt to a man who was perhaps very well acquainted or even friendly to them against a stranger, well, after all examiners are human, and it is by no means impossible that even a very fair minded man might be influenced a little by his feelings in a case like that.

That the fact of a man having a certificate is no proof that the certificate is his we must admit is true and we have used this argument to an examiner who suggested that all men holding a certain certificate were inferior to the local men, because he had a man come before him who held this certificate, and could not pass his examination. However, in the case of a man coming from another province or country, he usually has documentary evidence to prove his assertions, and if not should certainly be required to prove his status. In the case of a man holding a Dominion Certificate, it would be a simple matter to verify his claims. The British Board of Trade certificate has to be signed by the holder when he receives it and it is a simple matter to compare the signatures of the applicant for a position with the signature of the certificate. A photograph could be used as in the case of a

passport. The question of identification could be easily got over.

Now when it comes to a question of the lower grades of certificates and the issuing of special certificates for logging, hoisting, etc., we are at two different points. Mr. Goepel seems to think that if the certificates were limited to two grades, that the standard of qualification would be lowered or that a large number of deserving men would be prevented from earning a living. Neither of these undesirable conditions need accrue from the abolition of the third and fourth grade certificate. We have also in Ontario a fourth and third grade certificate, and as far as the fourth grade is concerned no one would be hurt by its abolition. This certificate must be held by any man who desires to operate a steam plant of between 25 and 50 h.p. or to operate under a certificated engineer a plant of 50 h.p. or over. In order to qualify for this certificate he must be 19 years of age, and have six months experience of operating, including at least three months operating in the boiler room. That means as far as its actual reading goes, that a man holding this certificate, can operate under a certificated engineer any size plant where he can get a job. Now independent of the certificate how much chance would he have of getting on a shift in a big plant, to take charge? He would have to have considerable more experience than the six months necessary or else be a very brilliant man. On the other hand there are hundreds of men who couldn't pass any kind of an examination, but who could take a watch in the engine or boiler room of almost any plant, and be perfectly safe. How many ships are there at sea today with the donkeyman taking charge of a watch, day after day and night after night, and carrying on in perfect safety. The qualifications of this candidate for the fourth class certificate, which he must have acquired after six months experience, include a general knowledge of all types of boilers, and a thorough knowledge of the construction, care and upkeep of injectors, a general knowledge of the different types of pumps, both centrifugal and reciprocating. This is not all, but it can be seen that the examiner must take a very liberal view of the interpretation of these qualifications—if any candidate passes the examination after six months experience. The qualifications for third class are such that if they were strictly adhered to, there would be no third class men passing until they had spent a very considerable time at the business, or else had a technical school or University education. This being so, would anybody be injured if a man was compelled to serve three years in the boiler room and engine room under certificated engineers, before he was allowed to sit for a certificate at all, and then give him a second class certificate if he could pass an examination of the required stiffness? In three years if he availed himself of his opportunities he could get a pretty fair knowledge of the practical end of his business, and then with study he could attain the theoretical end. After obtaining his certificate he could either take charge of a small plant or get assistant on a large plant and work his way up. It must be remembered that the average employer is governed far more by the types of plants the man has had experience in, and his record as ascertained from previous employers, than he is by the certificate he holds, so long as the latter will come within the law. We believe that such a method, with all the certificates of one standard, would not deprive any man of a job, and would tend to elevate the standard of engineers instead of lowering.

When it comes to a question of logging or hoisting engineers, we have a different proposition altogether. So long as a man knows enough to keep his boiler supplied with water, and to start and stop his engine, and keep it packed, the engineering side of his job is completed. When the question of becoming an expert operator of a hoist or a logging donkey is considered, how is he to attain that proficiency? In only one way, and that is by getting a start, and practising until he becomes expert. All the certificates in the world will not help him to do that. When a man is looking for a job of that kind, the logging boss will not ask him what university he graduated from, but will ask him to step on the platform, and demonstrate what he can do under the watchful eye of the boss, who will make sure that no one is liable to be killed until he is satisfied of the man's ability. These men are hardly to be included in the list of stationary engineers at all. The longshoreman who comes aboard a ship to run the winches while the cargo is unloaded, does not know a crank shaft from a piston, but he is a mighty expert winch handler. Where does he learn it? Usually, he is called on to try his hand for the first time when a regular man is short, and under the eye of the stevedore, he proceeds cautiously until he begins to get confidence in the job. Then he improves from day to day, until it becomes recognised that he is a capable man to put at a winch, and the news gets around among other bosses that another man is available in the field of winch handlers. Would a certificate help him any? Hardly.

We shall be glad to hear from Mr. Goepel again, and any other engineer who has ideas on this subject, as we believe the present state of engineers' certificates could be much improved taking Canada as a whole. We do not wish to push our views as the only correct ones, but to get the opinion of the men who should be the most interested.

In all probability the sum of $100,000 voted by the legislature at the last session for providing additional parliament building office accommodation will be utilized in the construction of the new building on the site of 17 Queens Park, Toronto. Honorable F. C. Biggs, Minister of Public Works, is having tentative plans drawn up for a new departmental block on the east side of the crescent.

A CHALLENGE ACCEPTED

The Editor, Power House:

I see in your issue of November 21st under the heading of "A Challenge," calling attention to an article I wrote some months ago on a tube fracture which occurred in the Montreal Tramways Co., Power House at Hochelaga.

I am very sorry if I seemed discourteous to our friend Mr. McLaren at the time in not answering his idea of the cause of the accident and results. If he will somewhat revive his memory he will remember I asked an opinion on the failure of a Rado-jet two issues before that and got no response from anyone. When one answer only was sent in to the second question I am afraid I was very disheartened, and I think a little disgusted at the lack of interest taken in subjects brought to the notice of Engineers in the Power House Magazine. Mr. Fenner and myself had a very lengthy and interesting discussion on both subjects during one of my visits to Toronto, which terminated to both our mutual satisfaction and the subject passed from my mind.

Our friend speaks in lighter vein of the accident. Probably if he had been in the mix up, as he calls it, he would have required a little more than 2½ per cent to steady his nerves.

I may tell him that the matter was thrashed out by some of the best brains in the States and Canada, and if our friend would like a copy of the reports sent back by experts I am only too willing to mail him one, but he must understand it is strictly confidential, as my company would not allow me to publish it. Otherwise I should only have been too pleased at the time, to let Power House publish it. However if our friend is anxious to air his knowledge before the engineering world, and will give the same explanation, I will tell him through the pages of Power House, how far he is from the truth. I am sorry I have not a copy of that date, as I send my copies away, and this particular one I sent to England, to be discussed, which was done. I am rather surprised at our friend in the previous article, on the same page, questioning such an authority as Mr. Pratt. He certainly is brave to throw himself in the limelight of the engineering world and dare to make such an assertion.

Before concluding, I would like to impress on Mr. McLaren's mind, that an engineer in charge of a 40,000 H. P. Plant has more on his mind than tube fractures and again if I seem discourteous, forgive me and enter into a good controversy without that touch of cavil, which ill becomes a man towards his brother engineer. As a concluding remark, my reputation as an engineer is in no jeopardy, from such discussions as our friend wishes to bring up.

Hoping, Mr. Editor, that this will fully answer the article in question.

Henry Wright, A. M. E. I. C.
Chief Engineer.

JAMES E. NOBLE REPLIES

In November 21st Power House, under the title "A Challenge" there is a letter in reference to a letter of mine printed in October Power House. Because I did not write a guessing reply to a letter of inquiry, sent in by Henry Wright of Montreal, some 18 months ago, (which letter I did not see) your correspondent proceeds to write nasty sounding words such as, "your correspondent so far has not risked his reputation by expressing an opinion."

It is just such egotistical writers and their ill-natured quotations that are responsible for some inexperienced writers refusing to put their pen to paper for publication.

Your correspondent practically admits he did not know the answer as to the cause of the trouble, but did this check him? Not so you could notice. He gave it long distance, absent treatment by guessing. Most engineers refuse to guess for publication, if they know, then it is different. Henry Wright of Montreal has had a long practical experience in very large plants. When such a man asks a question surely the man of, possibly, lesser experience should not be taken to task, even by suggestion, by a guesser, because he did not answer a letter he never read. In my letter I suggested that engineers, meaning young or old, experienced or otherwise, without distinction or prejudice would assist a lot of us who might encounter some unusual difficulty, if they would describe how they overcame some such affair. In thousands of cases experienced men in different lines of work have been helped over a hard point by some suggestion thrown out by an inexperienced helper. No one man knows very much when everything pertaining to engineering is taken into consideration. Your correspondent might just as well suggest that our Editor, who is also Engineering Instructor at Toronto Technical College, an expert in Marine, as well as stationary engineering practice, is afraid to risk his reputaton because he did not answer the letter in question.

It is much more satisfactory to have some engineer explain how he won out, than to have him offer some uncertain advice. However, the latter is often welcome and once in so often may hit the mark.

The foregoing is an answer to "A Challenge." In two different sentences he writes he will be listening, surely he understands this is wrong, he can see, not hear in print.

Because one man has written a letter of inquiry to which only one guessing reply has been sent, it shouldn't deter other engineers from sending in what they consider valuable information to Power House, it may be some other engineer will be thereby helped, even if this does not happen, no harm will be done. By all means put us wise how you won out in that bad time.—James E. Noble.

Editor's Note

We would request, that in this correspondence, between three good men, that personal recriminations be kept strictly in the background. We have the pleasure of knowing both Mr. Wright and Mr. McLaren personally, and have accepted a considerable number of valuable contributions from Mr. Noble, although it has not been my good fortune to meet him. All three have a long experience, and a pretty wide knowledge of engineering as applied to power plants, and between them can furnish much valuable information to brother engineers when they feel like contributing to "Power House." There is no objection to them having an argument on any point at all, but we would ask that in the interests of decorum, and for the good of the profession in general, that this argument be carried on in a parliamentary manner. The letters here published are not by any means in a conciliatory strain, and we remember a correspondence some time ago that descended to the level of more personal abuse. Gentlemen, keep clear of this style of letter writing, or the correspondence will die a sudden death.

HORSE POWER AND BOILER RATING

Editor, Power House:

In 1876 a committee of judges in charge of the boiler trials at the Centennial Exposition in Philadelphia recommended that a boiler horse power be the equivalent of the evaporation of 30 lbs. of water at 100° Fah. into steam at 70 lbs. gage pressure. This is equal to 33354 B. T. U. according to the Marks Davis tables.

In order to further simplify matters the American Society of Mechanical Engineers have recommended that a boiler horse power be the equivalent of the evaporation of 34.5 lbs of water at 212° Fah. into steam at the same temperature. This is equal to 33479 B. T. U.

In order to facilitate the calculation of electrical drives, etc., the late H. G. Stott suggested the myria watt be considered the equivalent of one horse power. A myria watt=10 kilowatts and the thermal equivalent of one K. W.=3412 B. T. U. A myria watt therefore would equal 3412 x 10=34120 B. T. U.

Boiler builders in rating their boilers allow 10 square ft. of heating surface per horse power in the case of water tube boilers and 12 sq. ft. in the case of return tubulars. The Boiler Inspection department of Ontario also allows 12 sq. ft. of heating surface per horse power for return tubular boilers.

The formers of the Stationary Engineers' Act, however, for some unknown reason decreed that 15 sq. ft. of heating surface in the case of a return tubular equal one horse power. Possibly it was the best they could get out of their boilers or possibly they thought the other fellows were wrong, but my suspicion is that most of us get a horse power out of less than 15 sq. ft.

I am satisfied that the present members of the Stationary Engineers' Board are aware of the fallacy of the rule and would appreciate an expresion of opinion on the subject by engineers. What is your opinion?—R. M. McLaren, 160 Dovercourt Road, Toronto.

OBITUARY

The death of Lord Mount Stephen occurred at his residence in Hertfordshire, Brockett Hall, Hatfield, England, on November 30th. Lord Mount Stephen was in his 93rd. year. He was born in Scotland in the rural community of Aberdeenshire, June 5th, 1829. He spent his early days there and in Banffshire. He never forgot his school days in Dufftown. He was born a commoner and was known as plain George Stephen. He started life as a shepherd boy, later going into a draper's establishment in Aberdeen. He soon entered the services of a shipping office in London. An opportunity of coming to Canada presented itself shortly after, and he came to Montreal in 1850. He entered business as a woollen merchant, in 1862 was in control of the business. He also achieved great success and amassed a great fortune in the textile manufacturing business. He became a director of the Bank of Montreal and in 1876 became president of that institution. Through his connection with the bank he became interested in railways. With his Scottish cousin, Sir Donald A. Smith, (later Lord Strathcona) he accepted the responsibility of building the Canadian Pacific Railway across the continent. The Canadian Government had only built 700 miles of the road and the enterprise was apparently doomed to failure. This railway syndicate, as it was then known, received $25,000,000,00 in cash and 25,000,000 acres of land as a subsidy. Difficulties of all kinds, some almost insurmountable, confronted the railway builders time and time again. Lord Mount Stephen's brilliant personality, his faith in the future of Canada, and his courage, were outstanding in the days of political and financial difficulties. In order to complete the road, the personal fortunes of both Lord Mount Stephen and Lord Strathcona were pledged. Many of his securities had to be sacrificed to raise funds. Lord Mount Stephen became the firt President of the Canadian Pacific Railway. He was plain Mr. Stephen when he was elected to this office in 1881. He held office until 1888 when he resigned.

His gifts to hospitals and other worthy objects were princely, and he distributed his vast fortune in a lavish style. For the past twenty-five years he has lived quietly in retirement in England but always took a keen interest in Canadian affairs.

If Guelph can raise $320,000 they will erect a new high and technical school. Day and evening classes will be held in such a school, but so far the matter is only in a proposed state.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

SIZE OF PUMP

Question:—Can you please tell me the size of feed pipe necessary for a 170 H.P. water tube boiler, carrying 100 lbs. pressure, and how to figure same. Also what size of duplex feed pump would be most suitable for it?

Answer:—It is first necessary to determine how much water must be supplied to the boiler for the given horse power, and if the boiler is to be run at over rating, allowance must be made for this. As one boiler horse power is the evaporation of 34½ lbs. water per hour, and the horse power is 170, then the quantity of water to be pumped would be 170 x 34.5 lbs. per hour. If we allow for a 50 per cent. over load it would be

$$\frac{170 \times 34\frac{1}{2} \times 150}{100} = 8797.5 \text{ lbs per hour}$$

As there are 62.5 lbs. in a cubic foot of water the number of cubic feet per hour would be

$$\frac{8797.5}{62.5} = 140.7$$

or say 141 cubic feet per hour. This gives 2.35 cubic feet per minute. Now it is necessary to limit the velocity of the water through the pipes to about 150 feet per minute, as if the velocity exceeds 200 feet per minute there is a great deal of loss by friction. The cubic feet per minute passing through the pump is 2.35, and this in cubic inches is 2.35 x 1728=4060.8 cubic inches. The velocity is to be 150 feet per minute and this is 1800 inches. If we divide the cubic inches per minute by the velocity we get the area of the pipe, and this divided by .7854 and the square root taken gives the diameter of the pipe. Put in mathematical form this will be

$$\sqrt{\frac{4060.8}{1800 \times .7854}} = \text{Diameter}$$

and diameter of pipe is 1.69 inches. Now this is over 1½, and the best thing to do is to take the next largest size, 2 inches, which will make the velocity less than 150 feet per minute, and provide ample capacity for the feed.

To determine the size of pump required we refer again to the cubic feet per minute required which is 2.35. As a duplex pump may be considered to be 80 per cent. efficient that is a slip of 20 per cent. is allowed, we must have a pump that will deliver that quantity of water net. We shall require then a pump having a capacity of 2.35 x 1.2= 2.82 cubic feet per minute. As there are two pistons, each one will have to deliver 1.41 cubic feet per minute. It is not desirable to have a feed pump moving too quickly, and a speed of piston of about 50 feet per minute is plenty. This is 600 lineal speed per minute. 1.41 cubic feet per minute, we should have an area of 4.06 square inches. This would give a diameter of a little over 2 and one quarter inches for the piston. In order to get the speed we should have to make at 60 strokes per minute with stroke of 10 ins. This is not at all in proportion, so we can tackle the question another way. We can use a slower speed and a larger bore which will be more satisfactory. If we determine the number of strokes we wish the pump to run, then we can make a bore and stroke to suit this speed. Let us take 30 as the number of strokes per minute, then the quantity of water per stroke will be 81.2 cubic inches. Let us assume a diameter of 4 inches which gives an area of 12.5 square inches. This divided into 81.2 cubic inches gives a stroke of 6.48 or say 6½ inches. We can make the stroke 6 inches and let the pump run a little faster, and then we should have a pump with water ends of 4 inches diameter and 6 inches stroke.

For the steam cylinder we should make the ratio of these areas about two to one. If the water end is 4 inches then the square of 4 is 16, and twice this is 32. The square of 6 is 36 so 6 inches would be about right for the steam cylinder. The area of steam piston can be found by calculation if wished.

We have then a pump with 4 inch water pistons and 6 inches stroke, making 30 strokes per minute each side, or 60 strokes per minute in all. Its capacity is theoretically

$$\frac{4x4x\ .7854x6x60}{1728} = 2.6 \text{ cubic feet per}$$

minute. This gives 156 cubic feet per hour, and 9750 lbs. per hour. This gives a margin over the actual requirements of

$$\frac{(9750-8797.5)x100}{8797.5} = 10.8 \text{ per cent.}$$

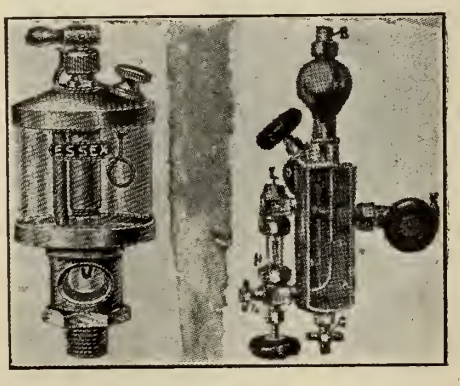
when the boiler is working at 50 per cent. overload.

It is cheaper in first cost to get a pump just large enough to run the boiler at actual rating, but it is far cheaper in maintenance and repair costs, and for reliability, to get a pump large enough to take care of at least 50 per cent. overload. If there is a chance of future enlargements these also should be taken into account when considering the installation of feed pumps.

SIGHT FEED LUBRICATORS

Question:—How would you describe a sight feed lubricator?

Answer:—Sight feed lubricators are of two kinds, those for lubricating bearings and those for lubricating the interior of cylinders and valve chests. The sight feed lubricator for the bearings merely consists of a container for the oil, fitted with a spring needle valve which can be adjusted to permit of the



Sight Feed Lubricators

flow of a definite quantity of oil, and a hollow stem which screws into the bearing and also contains a glass tube through which the oil can be seen as it passes from the container to the bearing.

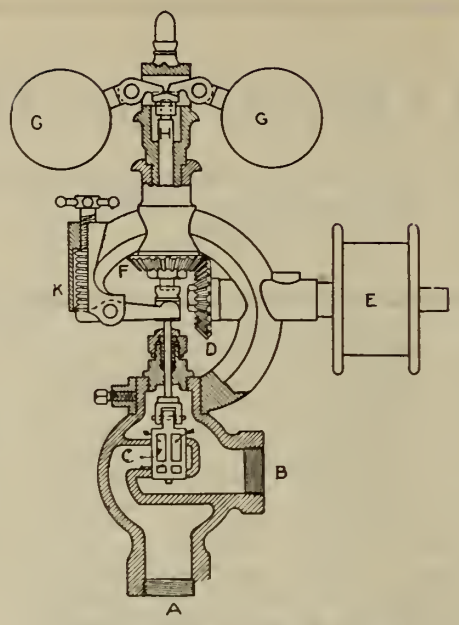
The sight feed lubricator for the interior of cylinders and valve chests consists of a cylinder for containing the oil, a chamber above this for condensing the steam, which is connected to the top of the condensing chamber. A second connection from the side of the lubricator enters the steam pipe through which the oil passes. There is a gauge glass on the containing cylinder to show the amount of oil in it, and a glass through which the oil passes on its way to the steam pipe. The action is simple. The steam connection to the condensing chamber from the steam pipe some distance above the connection for the feed.

When the valves are open communication is established through the lubricator from one connection to other, and the pressure is equalized. There is however a head caused by the water contained in the condensing chamber, and the pipe above it. The water drops to the bottom of the condensing chamber and forces the oil down the small pipe and through the gauge glass and then into the steampipe through the side connection. The chamber is filled with oil from the plug shown on the side, and there is a valve above the condensing chamber as well as on the inlet so that the lubricator can be shut off for filling, cleaning, etc. The valves on the sight feel glass are of the needle type, thus allowing a very small drop of the oil to pass through at a time. The sight feed glass fills with condensation through which the oil globules pass.

THROTTLING OR AUTOMATIC ENGINE

Question:—Will you please tell me through the Question Box what is the difference between a common throttling engine and an automatic engine? Also how would you describe a sight feed lubricator?

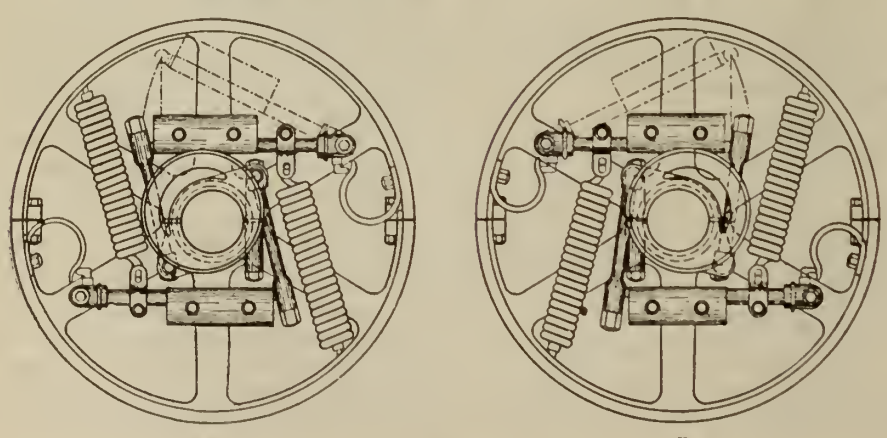
Answer:—In the throttling engine, the governor performs its task by diminishing the opening of the throttle valve which admits steam to the steam chest of the engine. The throttling governor, a cut of which is shown here, depends for its action on the speed with which the balls revolve around the axis, this being governed by the speed of the engine. The governor is proportioned so that at the speed set for the engine to run, the governor keeps the throttle valve fully open. As the speed of the engine increases the centrifugal force of the balls tends to make them increase the diameter of the circle in which they revolve. In so doing, they shorten or draw up the rods to which they are attached, and which are in turn attached to a lever, at the opposite end of which the throttle valve spindle is held by a link, the fulcrum being in the centre. Raising the end of the lever to which the governor is attached, naturally depresses the end on which the throttle valve is held, and



Throttling Governor. A to steam chart. B to boiler.

closes it down an amount corresponding to the height and the lengths of the arms of the lever. The fly ball governor is made in different syles but the principle is the same in all of them. In the case of a Corliss engine, the governor actuates two rods, which in turn move the cams around on the valve spindles making the cut off sooner or later. In this respect the action is different, inasmuch that instead of throttling the steam in the steam pipe, the cut off of the steam valve is altered. The effect of throttling in the ordinary engine is to effect what is called wire drawing of the steam which practically means that not only is the quantity of steam admitted lessened, but its pressure is diminished by the friction of passing through the narrow opening.

In the automatic engine, the governor is placed in the flywheel, and acts through the displacement of weights caused by the centrifugal force generated by the speed of the wheel. As the engine speeds up, these weights tend to move further from their centres, and in doing so affect the cut off in this way:—the eccentric, instead of being fastened to the shaft, is fastened to the arms of the governor, and is free to move around the shaft and in some cases to move across the shaft as well. In the case of the eccentric moving around the shaft only, the effect is to increase the angle of lead of the valve. This results in making the lead earlier, the cut off earlier, release earlier and compression earlier. This means that the admission of steam is less, while the compression is much increased, with the result that the speed is lessened. In this case there is no wire drawing of the steam, it being still at the full pressure in the steam chest, and the full benefit of the expansive power being retained, while the steam which is contained in the cylinder at compression is not lost, but is alternately compressed and expanded. In the case of the eccentric approaching closer to the centre of the shaft, thus diminishing the amount of opening of the ports, while still retaining the expansive properties of the steam. There are numerous forms of shaft governors, but the general principles of them all are similar. The illustration shows one of these forms.



A *B*

Shaft Governor.

BALL CHECK TROUBLE

Question:—I should like to know through the columns of Power House why a new ball check on the feed pipe of the boiler makes an awful humming noise when the pump is in action.

Answer:—Humming of a ball check valve, or chattering of an ordinary flat or mitre seat check valve, is usually experienced when the rate of feed is such that the valve is lifted very slightly from its seat, and kept in a sort of balance by the incoming feed and the pressure from the boiler. A condition arises when this feed forcing itself past the narrow opening of the valve, causes a vibration which communicates itself to the pipe with a humming or chattering sound. As a rule a change of speed of the pump will effectually stop this noise, which can be very unpleasant. It has been our experience with ball valves that it is more difficult to keep them from banging than from chattering. What has been the experience of other engineers along this line?

Another Monthly Statement has been issued by the Canadian National Railways. The President, Mr. D. B. Hanna, has stated that the net earnings for the month of October, 1921, are $1,036,130. Comparing these figures with the September net earnings, which were $500,000, it shows an increase of 105 per cent over last month's total. Figures supplied by the Dominion Bureau of Statistics, at Ottawa, show that the operating ratio published by the Canadian Railways for August was 86.41 per cent., which was a decided improvement over August last year. In August, 1920, the ratio was 98.82 per cent. The improvement was effected by reduction in operating expenses, the greater portion of which was brought about by a $5,118,010 reduction in pay rolls.

Present Status of Coal Carbonization

Carbonization of Coal at Low Temperatures and Its By-Products in Their Various Forms, According to Investigations of the U.S. Bureau of Mines. Read Before the American Gas Association

By JOSEPH G. DAVIES

FOR THE past twenty years an enormous amount of experimental work has been done in this country and in Europe on the carbonization of coal at low temperatures. Most of this work has been carried out on a laboratory scale, or at least on a semi-commercial scale, and only recently have results been obtained that can be used directly by the carbonization engineer. One object in view in the experimental work has been to learn from a purely scientific standpoint more of the composition of coal and its thermal decomposition. Another object has been the discovery and commercial development of more economical methods for processing fuels than the well-known high temperature methods. This paper deals more particularly with the latter phase of the work.

Parr and his co-workers in this country, Stansfield in Canada, Wheeler, Jones, Burgess, Bone and Lewes in England, and Fischer and Gluud in Germany, have been particularly active in research on the scientific aspects of the problem and on the technical application of their results as well. The problem of coal constitution and thermal decomposition is a long way from solution, although considerable progress has been made. Of the chemical constitution of coal, little is known as yet, but the yield of distillation products obtained under fixed temperature conditions, as well as their general nature has been empirically worked out; the actual chemical reactions involved, however, have not been fully explained.

The technical application of low-temperature carbonization is still in its infancy and development has been slow, mainly for three reasons—(1) adequate fundamental knowledge of coal constitution and thermal decomposition is lacking; (2) evolution of suitable retorting apparatus is slow, owing to the low heat conductivity of coal and the consequent difficulty of designing retorts which have appreciable capacity and also the requisite low temperature gradients; (3) a market for the rather special distillation products, however valuable they may prove to be in the future, does not exist and must be created.

Fundamental Considerations

(a) What is meant by low-temperature carbonization?

Authorities differ somewhat as to what is meant by low-temperature carbonization of coal. Parr, (Parr, S. W., and Layng, T.E., Low temperature carbonization and its application to high oxygen coals, J. Ind. & Eng. Chem., vol. 13, No. 1, p. 14, January, 1921) who is interested mainly in converting Illinois coals into smokeless fuel for domestic use, defines low-temperature carbonization as "destructive distillation at temperatures not in excess of 750 deg. or 800 deg. C."

Bone (Bone, W.A., Low temperature carbonization of coal, Gas. Jour., vol. 155, July 6, 1921, p. 31) considers temperatures 550 deg. to 600 deg. C. best for low-temperature carbonization of British bituminous coals. Gluud, (Gluud, W. Die Tieftemperature Ver Kokung der Steinkohle, second edition, 1921, published by William Knapp, Halle.) defines low-temperature carbonization as carbonization within such temperature limits that primary tars only are obtained. He fixes the temperature range at 500 deg. to 600 deg. C. He states further, however, that 800 deg. C. is the temperature at which primary tars begin to decompose appreciably, in which statement he is in substantial agreement with Parr. It would seem to the writer that a logical definition of low-temperature carbonization should specify carbonization under such temperature conditions that primary tars (chiefly paraffins and tar acids) are not decomposed to any appreciable extent, the highest temperature to which either coal or tar is exposed being not in excess of 750 deg. C. It must be considered, of course, that different coals may require slightly different temperature treatment, although Fischer and Gluud found that tar of the same general characteristics was obtained from a large number of bituminous coals when distilled under the same conditions. For the production of the best coke, it is probably best to carry the distillation temperature as high as possible.

(b) Amount and character of products obtained by low-temperature carbonizations:

The figures for yield of products given by technical writers for various low-temperature processes vary so widely that it is hardly worth while to discuss them here. The chief cause for this variation can not in general be explained by imputing to one process greater merit than another, but will usually be found in some variation in distillation conditions unexplained or perhaps not fully understood by the writers. For a given distillation temperature, any process should yield the same quantity of by-products. The following figures are taken from results reported by the most prominent experimenters working on a small scale and under carefully controlled conditions with coals of the same rank and it is believed they represent to a close approximation what should be obtained technically with the right process and proper control.

(1.) Tar oils. The tar oils form what is perhaps destined to be the most important product of low-temperature carbonization technically, since on account of their similarity to petroleum products they can be used largely as substitutes for petroleum oils in the industry.

It is now pretty well established that these primary tar oils from bituminous coals consist chiefly of phenols and hydrocarbons of the paraffin, napthene and olefin series, together with substituted aromatic compounds which are for the most part methylated. According to Gluud (same reference) 10 to 15 per cent of the hydrocarbon portion of the tar consists of pure paraffins, the lighter part of the hydrocarbon portion being richer in paraffins, and the heavier part containing higher percentages of napthenes, unsaturated bodies and hydro-aromatic compounds. The amount of phenols in the raw tar varies from 15 to 50 per cent, according to the volatile content of the coal the remainder being hydrocarbons. The hydrocarbon portion of the tar is very similar chemically to Russian petroleum; it is likewise very complex and only a very few pure chemical compounds have been separated from it and identified. Bituminous coals yield around 10 per cent primary tar. On refining this tar by distillation wth superheated steam, a method which he recommends, Gluud obtains the following products:

Refined products obtained from low-temperature tar from gas coal.

Boiling range (deg. C)	Yield per cent. of tar	Product
20—100 deg.	3	Paraffins from the gas
100—200 deg	10	Light oil
200—300 deg.	12.5	Low viscosity oil (solar oil, motor oil, polishing oil) containing 1% fluid paraffin oil
300 deg.—to dry point	15.0	Lubricating oil (viscosity, V50—20—30 deg. E.) containing 1.5% solid paraffin
	9.0	Red resin.

*Presented before the meeting of the American Co's Association, Nov. 9, 1921, Chicago.

In addition to the above products, 50 per cent. of the tar was obtained as phenolic compounds boiling between 200 deg. C. and the dry point.

The above results agree fairly well with those obtained by Parr, (Parr, S. W., and Olin. The coking of coal at low temperatures with special reference to the properties and composition of the products, Bull. 79, Illinois Engineering Experiment Station), and may be taken as representative of low-temperature tar oils obtained under conditions which are within the meaning of our definition. Their technical application will be discussed later.

(2) Coked residue. The coked residue in general amounts to from 70 to 75 per cent. of the coking or semi-coking coal charged; it is not so hard as metallurgical coke and contains from 10 to 18 per cent. volatile matter. This coke is easy to burn without smoke, ignites readily, and should make an ideal domestic fuel.

It is claimed that coke suitable for this purpose can be made from coking coals unsuited for the making of metallurgical coke. Parr (same reference) claims to be able to make a good domestic coke from Illinois coals of high oxygen content, and samples shown the writer would seem to bear out this claim. The main feature in Parr's process is a preliminary heating to 300 deg. to 400 deg. C., after which the coking takes place for the most part autogenously, due to heat of reaction of the coal undergoing carbonization.

(3) Gas.

Writers differ considerably as to the amount of gas produced, but it is probably safe to assume that the yield for fair gas coals is between 5,000 and 6,000 cubic feet of 650-750 B.t.u. gas, per ton of coal carbonized. Bone (work cited) conservatively puts the gas yield at from 300 to 400 cubic feet per ton. The composition of this gas, according to Lewes (Lewes, V.B., The carbonization of coal, D. Van Nostrand Co., 1917) is approximately as follows:

	Per cent.
Hydrogen	27.5
Saturated hydrocarbons	
Methane 48.0	
Higher members 10.1	58.1
Unsaturated hydrocarbons	3.0
Carbon monoxide	7.3
Carbon dioxide	2.5
Nitrogen	1.6
Total	100.0

Uses to Which Low Temperature Products are Especially Suited

One must discount to some extent the claims of exponents of the various low-temperature processes as to the special uses to which their products suited and to what extent they are destined to displace other materials for which the demand is well established. As a matter of fact, there is now no well established demand either in this country or abroad for low-temperature products as such or as substitutes for other materials. The writer believes that development, though it has been slow and beset with technical difficuties, has been in advance of the demand for materials produced. Any process, in order to be a success financially, must now bear the burden of creating a demand for its products, and this has been the chief reason for slow development of low-temperature methods up to the present time. As for the future, perhaps in the near future, there is every reason to believe in the success of a low temperature carbonization industry. The main factor which will bring this about is the rapidly increasing demand for liquid fuels of all kinds. Every resource will be drawn upon, and coal, particularly coal of low rank, will probably be for a long time among the cheapest of raw materials. It may therefore pay in time to "process" coal for oils as the main product. So long as there is no definite demand for the special products which "processing" will supply, one might as well think of going to the trouble of refining cast iron; making a fine grade of tungsten steel, for example, to use for window weights, as to think of "processing" coal. This of course does not apply to well established methods for processing coal where gas or metallurgical coke are the special products sought.

It must not be expected that the profits to be derived from low-temperature processing of coal will be large. To quote Sir George Beilby (From the James Forrest lecture on "Fuel problems of the future" delivered June 28, 1921, before the British Institute of Civil Engineers), Director of the British Fuel Research Board, "Low-temperature carbonization can only be established on a sound commercial basis with low operating costs and a very moderate margin of profit."

(a) Uses for the tar oils: The refined light oils from the tar may be sold as motor spirit, for which there are good prospects of ever-increasing demand. The amount of oil available for this purpose may be taken at around 3 gallons per ton of coal carbonized, the exact amount depending upon the volatile content of the coal. There is a question in this connection, as to how far the refining of oils of this character must be carried to fit them for use in motors. It is possible and even probable that refining methods other than those now used for petroleum, and high-temperature light oils, may be developed which will release a larger proportion of the low-temperature light oils as refined motor spirit stock than can now be counted on. The Bureau of Mines is just at present working on the problem of motor spirit refining in connection with oils similar to low-temperature light oils. The heavy low-temperature oils, as previously indicated, consist chiefly of acids (phenols) and neutral hydrocarbon oils. The phenol content is high, it amounts as much as 50 per cent of the total tar yield of 24 gallons per ton of coal, according to Gluud (work cited.) He also finds that the higher the total tar yield, the higher its content of phenols.

One large use for low-temperature tar acids will doubtless be in connection with timber preservation.

According to Coffin (Coffin, F. P. Uses for low temperature tar oils, Gas Age-Record vol. 48 No. 3, p. 97, Aug. 6, 1921) between 90 and 100 million gallons of such oil were used in 1913 in this country for that purpose, and two-thirds of this amount was imported. Evidently there is a present demand for low-temperature tar acids, and the only question remaining to be decided relates to their suitability for the purpose. Coffin states that they are even better than high-temperature tar creosote. Other uses mentioned for these tar acids are, insecticides (including dipping oils for live stock), disinfectants, and flotation oils. It is not clear that there is an appreciable shortage in the present supply of these chemicals, although a growing demand may probably be assumed.

According to Gluud, the heavy hydrocarbon oils, and in fact crude tars from which the acid is not removed, have found extensive use in Germany as lubricants during the war. He adds that even now most low-temperature tar produced is used directly for that purpose, although really high-grade lubricating oil can be made from the crude tar on distilling with steam and removing the phenols.

The total tar oils, with very little refining, may be used as fuel oils, although demand for them for other purposes should preclude such use. Armstrong, (Armstrong H. L., low temperature carbonization, Gas World, vol. 74, No. 1902, p. 12, January 1, 1921) of the Low Temperature Carbonization, Limited, states that at the Barnesley plant fuel oil complying with the Admiralty specification, is made by steam-distilling the crude oil till sufficient light oil is removed to bring the remainder within the Admiralty flash point specification and then decanting the water.

(b) Uses for the coke: it is claimed both in this country and in England that low-temperature coke is an ideal fuel for domestic heating. This seems reasonable, particularly in view of the quality of coke obtained by Parr from coals rather inferior from the coking standpoint. It should be feasible and profitable to coke low-rank semi-coking coals primarily for solid domestic fuel and light oils. However, the American public is slow to take up the use of coke, and the same seems to be true in England. The public aversion to coke may be due partly to prejudice and partly to lack of knowledge of the best ways to burn it; the writer is inclined to believe both factors are responsible. In any event, the public must be educated to its use before there will be a good demand for low-temperature coke for domestic heating.

(c) Uses for the gas:

The small amount of surplus gas available for distribution (at most 3,000 cubic feet per ton of coal carbonized), makes the gas a product of lesser importance. It is, however, of good quality and suitable for distribution for domestic heating.

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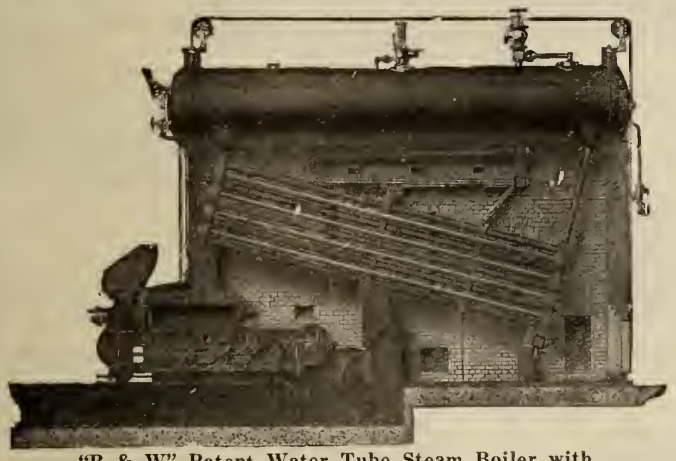

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2	25.72	20.13	32.01	38.67
2½	40.66	51.19	.....	.....
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4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
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Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	17	Atlas	19
Peerless	22	X Empire	14
XX Grand	16	Ideal	18
Superior	21½	X Press	13
X L C R	15		

Colored

Lion	12½	Popular	10
Standard	11	Keen	9
No. 1	14	Fancy	14

Wool Packing

Arrow	30	Anvil	20
Axle	25		

Washed Wipers

Select white.	20
Dark colored.	13
Mixed colored	14

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	34 00	$39 00
Spelter	7 25	7 50
Lead	6 50	7 50
Antimony	7 25	8 25
Aluminum	28 00	30 00

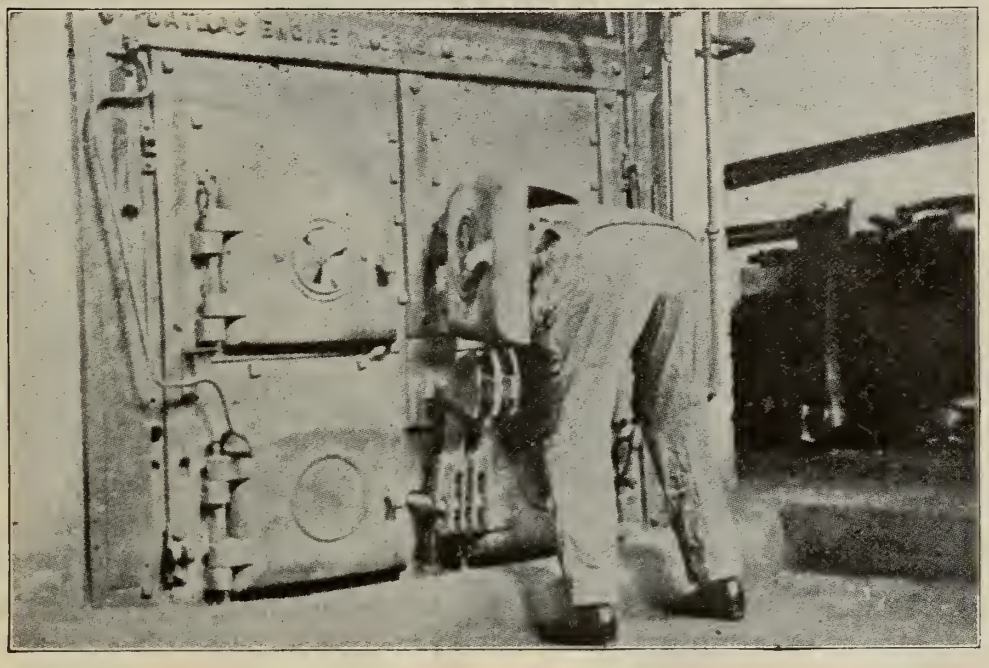
Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Try Our Service



The illustration above shows one of our representatives about to investigate the "in'ards" of a boiler. Whatever your requirements, whether you contemplate a small repair job or the installation of a complete boiler setting, let us know, and our nearest representative will show you how

PLIBRICO JOINTLESS FURNACE LINING

can best be applied, and will help you apply it.
No matter how inaccessible your plant, or whether you will require one drum of PLIBRICO or a carload, we of the Jointless Fire Brick Company are ready to give you our best service. Try us.
PLIBRICO is a plastic furnace lining that when molded into shape and properly baked and vitrified forms a setting that is solid as rock and resistant to heat up to 3,100° F. No skilled labor is required, but PLIBRICO can be applied by any man who can wield trowel and mallet.
Ask for our book L-43 on "Modern Furnace Building." It contains valuable information.
PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

Distributors: Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman's, Ltd., Calgary, Alta.

JOINTLESS FIRE BRICK CO.
1142 CLAY STREET, CHICAGO, ILL.

JONES STOKERS

POWER interruptions will not, and should not, be tolerated in modern plants. That is why Jones Stokers are favorites for plants of practically every size. Their rugged simplicity makes shutdowns for repairs next to impossible. Fuel and air are automatically controlled; little attendant labor is required.

In the "A-C" (Automatic-Cleaning) type, fires are automatically cleaned.

Retorts may be individually controlled —an exclusive feature.

Clinkers do not form on bridge or side walls.

The under-feed principle of combustion (originated in Jones Stokers) insures maximum economy of fuel at all loads.

These, and other distinctive features that make the Jones Stoker "pay for itself—then pay dividends," are covered by the new catalog.

Have you your copy?

The Under-Feed Stoker Co. *of* Canada, Limited

81 Victoria Street, Toronto

Quebec and the Maritime Provinces: The Cleaton Company (Canada), Ltd., Southam Bldg., Montreal.

Alberta and Saskatchewan: Mr. J. Twomey, Camrose, Alta.

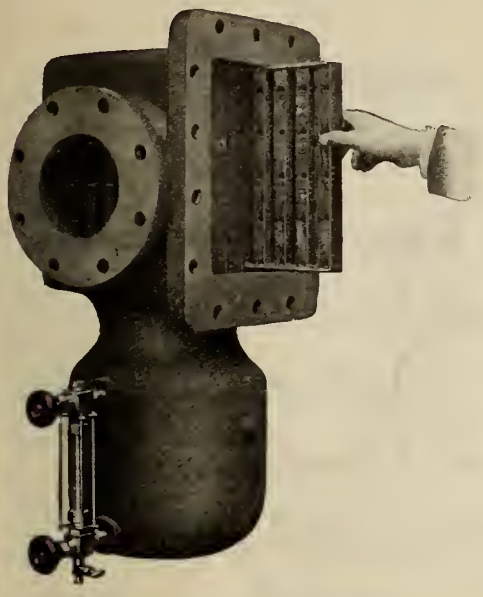
British Columbia: E. A. Earle, Ltd., 739 Hastings St. W., Vancouver, B.C.

Manitoba: W. W. Hicks & Co., 567 Banning St., Winnipeg.

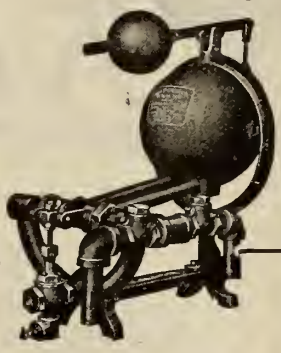
The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co. of America are made available for Canadian power users. Thus this strictly Canadian Stoker is backed by world-wide experience and unequalled engineering ability.

BUNDY Steam Traps and Separators



Are the Scientific Answer to Engineering Problems!



THE BUNDY OIL SEPARATOR

is a device perfected to the finest degree possible. In actual service it is the only type that fulfills the following requirements. Insures maximum removal of oil from steam. Prevents steam from again picking up oil. Maintains high efficiency because it is easily cleaned.

Bundy Oil Separators and Steam Traps can be obtained at any of our branch agencies. Drop a line for further particulars.

Return Trap

Bundy Steam Traps can be safely bought on their rated capacity. They are made of cast iron and semi-steel—built for long service. Rigidly tested under actual working conditions.

The Mason Regulator & Engineering Company, Limited

Head office and Works: 135-153 Dagenais St., Montreal, Que.

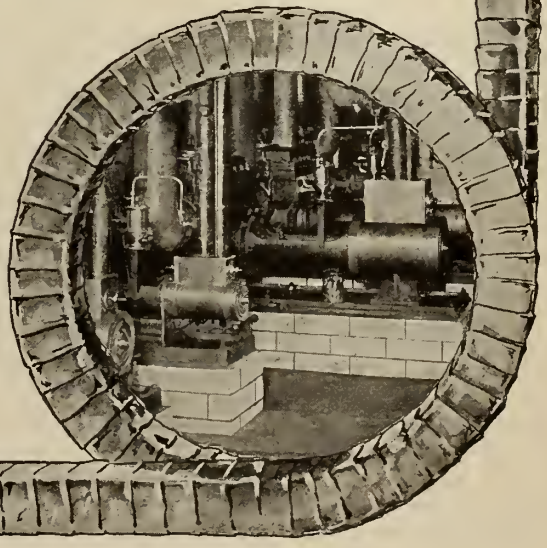
"Toronto Agents; Valve Engineering Co., 160 King St., West.
Agencies at: Quebec, Halifax, St. John, Winnipeg and Vancouver."

John Crane

Eight Years of Packing Service
JOHN CRANE Flexible Metallic Packing Shows Greatest Results in Constant Service

Eight years ago Chief Engineer, N. Gross, of the Standard Oil Building, Chicago, installed JOHN CRANE Flexible Metallic Packing in the boiler-feed pump pictured below. Mr. Gross reports packing and pump in good order after eight years and has standardized JOHN CRANE on all service.

JOHN CRANE holds this long service record because of its scientific, practical construction. Made of babbitt foil and graphite, it brings Packing science "The Babbitt-bearing Principle," and while responding to the slightest pressure of the gland never dries out, but remains compressible and will not score rods.



Write for your copy of "THE ANSWER" a book that tells unusually interesting things about packing problems

The R. C. MILLER OIL & SUPPLY CO.

38 & 40 YOUVILLE SQUARE, MONTREAL

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TEMPERATURE INSTRUMENTS
INDICATING-RECORDING-CONTROLLING

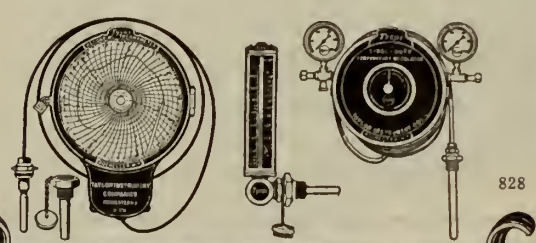
Temperature Problems

that seem new have, in most cases, been solved for others by *Tycos* Engineers. Your problems are our concern. Send to-day for catalogs and data, giving specific needs and firm connection when you write. No obligation.

Taylor Instrument Companies

110-112 Church St., Toronto, Ont.

There's a *Tycos* or *Taylor* Temperature Instrument for every purpose.



828

Make a good article,
Advertise it,
Keep your promises,
Keep on Advertising,
Deliver the goods,
Keep on Advertising—
and you will get the
business.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

New Ice Breaker to be Built; Machine Tools Are Still Quiet

MONTREAL, December 1st.—This week has seen the placing of another large contract with a local firm. The Hon. C. C. Ballantyne announced on the evening of the 24th, that the lowest tender for the proposed new Government ice breaker was that of the Canadian Vickers, Ltd., and that the contract would be awarded that firm shortly. It will be remembered that an ice breaker was constructed for the Government in 1914 but owing to the conditions existing at the time, it was sold to the Russian Government. It has been felt that a new ice breaker would be constructed at an early date to replace the original one. Figures on the ice breaker were obtained some eighteen months ago and it was found that it could not be constructed at a reasonable cost. The lowest bid at that time was in excess of $2,000,000. The recent bid of the Canadian Vickers firm is $1,580,000, at which figure the contract will be placed. By waiting the year and a half it has been able to place the contract for a sum of $700.000 less than the tenders received early in 1920. The contract has been let at a most opportune time as there is a great deal of unemployment in the class of labor that will be employed on the ice-breaker. The breaker will be employed on the St. Lawrence and through its operations it is thought that considerable time can be added to the length of the navigation season. The contracts that have recently been placed for work of various natures in the engineering field have done a great deal to restore plants to their usual activity. The steel for the new Mount Royal Hotel has been delivered and is being rapidly passed into the Dominion Bridge Co. shops. It is announced that the erection of steel will be started on Dec. 15th. The sale of steel, sheets, bars and pig iron seems to be about as active as has been usual for the last few weeks. Generally, the whole steel and iron business is in a very satisfactory condition when all things are considered. The placing of the large orders has given consumers and shop men a great deal more confidence in the markets and will have a good influence in starting 1922 off at a good pace.

For the past few weeks there has been very little change in the volume of business. From some quarters a slight gain is reported, while in a few instances a slight decrease is reported. On the whole there is probably a net gain. There is a

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

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ENGINEER—HOLDING ONTARIO CERTIFICATE, thoroughly experienced in refrigeration and electricity is open for position. Box 17821 Power House, Toronto. P. 4. H.

WANTED—SITUATION AS GAS ENGINEER for producer or city gas, gasoline or kerosene engine. Preferably for small electric light plant, able to do own repairs, climb poles and do own wiring and take full charge. Apply Box 31821. Power House. p.2.h.

INSTRUCTION BY CORRESPONDENCE FOR First and Second Class Certificates, any province, stationary or marine. Terms and particulars on application. Box 13921, Power House. Ph2

EXPERIENCED MACHINIST WITH ENGINeer's certificate, good at general repair work desires position. Apply Box 14921 Power House, P2H

ENGINEER DESIRES POSITION IN POWER plant, experienced with oil burners, holding 3rd class papers. Box 24921 Power House. p.h.

TECHNICAL COURSES

NOVA SCOTIANS — SPECIAL ATTENTION. The Technical College now offers new, Correspondence Courses in all subjects important to men engaged around power house plants such as Steam Engineering, Blueprint Reading, Use of Slide Rule, Shop Mathematics, Mechanical Drawing, Practical Electricity, Electric Wiring, Gas and Oil Engines and many others.

Cost per course from $6.00 to $14.00.

Write for full information to Technical College, Halifax, N. S. P2H

SITUATIONS WANTED.

STATIONARY ENGINEER DESIRES POSITION as engineer or fireman. Holds second class certificate, 20 years experience. Apply to Box 151121, Power House.

EQUIPMENT

WE BUY IDLE EQUIPMENT OR MACHinery; call or write, mentioning Power House. H. W. Petrie, Ltd. Toronto.

MACHINERY FOR RENTAL — WE WILL rent by the month motors, hoists or contractors' plant of any description. Apply, mentioning Power House, H. W. Petrie, Limited, Toronto.

ELECTRIC MOTORS—NEW AND SECONDhand; electric machinery repaired; we also buy motors. Apply, mentioning Power House. The Electrical Engineering Co., 122 Wellington West, Toronto.

Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap

Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admissions of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds. Being open at starting, it cannot become air bound, thus doing away with air cocks or vents.—Does Not Freeze.

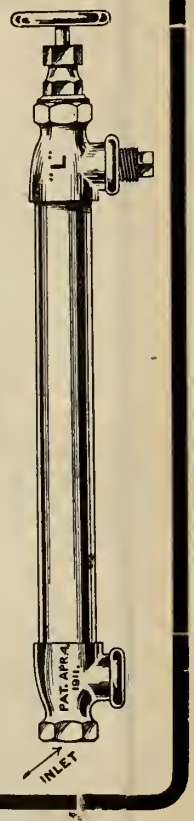
It is capable of draining from 900 to 1,500 feet of one inch pipe.

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to

J. T. Long
84 Adam St.
MONTREAL, CAN.

If your dealer does not sell it, write direct. No. 2



CAST IRON STORAGE TANK

Storage tanks of cast iron are rapidly growing in favor because of their permanent, sturdy structure, low maintenance costs, long life, ease of erection and correct engineering design.

The American Cast Iron Storage Tank has just been developed by the Conveyors Corporation of America, Chicago. It has been carefully tested under a wide range of conditions and is a pronounced success.

The tank was not designed to hold liquids but for dry storage purposes. Among materials that can be successfully stored in this tank are ashes, coal, building materials, foundry supplies such as coke and sand; chemicals and allied raw materials such as granular fullers earth, gilsonite, kieselgur, bauxite, potash, animal charcoal,—in fact all loose, bulky materials that are ordinarily stored in silos tanks, hoppers and bins.

Some advantages of the cast iron storage tank are its long life and low maintenance costs. Cast iron tanks resist corrosion, abrasion and rust. They are easy to erect, and unskilled workman are able to put this tank together, so simple is its construction.

It is cylindrical in shape, erected on a 5 inch reinforced concrete slab which is supported on a structural base or tower, built up of standard fabricated structural shapes.

The body of the tank is built up of cast iron radius plates, held vertically between cast iron H-sections. The tank can be built to any convenient height.

The Conveyors Corporation has issued a folder giving illustrations and specifications of the American Cast Iron Storage Tank. Copies will be sent free on request.

A MODERN TRANSFORMER SUBSTATION

The Glory Sub-Station of the Penn Public Service Corporation of Clearfield, Pa. is an example of the most up-to-date methods of construction of transformer sub-stations. This sub-station receives power from the new Seward Power Plant, which is located on the Conemaugh River near Seward on the main line of the Pennsylvania Railroad, about ten miles west of Johnston. The 66,000 volt transmission line extends in a north west direction to the Glory Sub-Station about nineteen miles distant, transmitting a large block of power from the Seward Plant to Clearfield, Indiana Counties.

The sub-station building is a structure of concrete, brick and steel, housing the control switchboard and auxiliary devices. The transformers, electrolytic lighting arresters and high voltage circuit breakers are all located out doors, the high voltage buses being suspended from a steel overhead structure of up-to-date design.

The main step-down transformers consist of four-2500 kv-a., single phase oil insulated, self cooled units of the radiator type. Three of these transformers are normally in sevice, the fourth being held as a reserve. The transformers are mounted on wheels and by means of transfer trucks can be quickly removed from the outdoor switch yard for repair or shipment. The secondary side of the transformers delivers 22,000 volts to the low voltage busses, from which feeders distribute the power to various points in Indian and Clearfield Counties.

These transformers together with the oil switches, lightning arresters and auxiliary equipment were furnished by the Westinghouse Electrc & Manufacturing Co.

ANNOUNCEMENT

The Coppus Engineering Company of Worcester Mass., have opened a branch office at 315 Mappin Building, Montreal. This branch will be in charge of Mr. W. L. Hunter, and will look after the territory in Eastern Canada, including the Province of Quebec. The various lines manufactured by the Coppus Engineering Company will be handled by the branch office, and include several types of blowers, turbo pumps, and turbines.

Is Canada's Frozen North A Myth ?

Vilhjalmur Stefansson, the Canadian explorer-author, in an article in MACLEAN'S MAGAZINE for December 15, entitled "Northward the Course of Empire," asserts that the stories of intense cold and other unendurable conditions in the sub-Arctics of Canada are all pure poppycock. He points out in this, the first of a series of four articles, that before the trans-continental railways were built, the same assertions were made regarding the fertile Prairie regions of Manitoba, Saskatchewan and Alberta that are now being made about the sub-Arctics.

Every Canadian interested in the development of his own country should be versed in the potentialities of the "wider Canada" beyond our present horizon of development.

The Christmas number of MACLEAN'S MAGAZINE, out

December First

is beyond doubt the finest in its history. There are contributions from such writers as Leacock, Agnes Laut, Alan Sullivan and Archie McKishnie; but MACLEAN'S did not gain its reputation by going after "names," and there are also other articles by lesser-known writers, including a delightfully poignant story by Frances Beatrice Taylor—her very first.

A Remarkable Offering of Timely Articles and Entertaining Fiction

Little Theatre of the Hills—Canada—by Agnes C. Laut: A plea for the development of Canadian national consciousness. Are we making the best of our national virtues and characteristics?

Frederick Niven: A Canadianized Englishman has a few remarks to make about those newly arrived Old Country men who come out to Canada to make good and then indulge in bootless criticism.

Little Ukraine in the Canadian West—by Mrs. Charlotte Gordon: Something about one of our alien colonies which does not desire to remain alien.

Age and Occupation Determine Food Needs—by William Fleming French: An authoritative food article which answers the question "What Should Henry Eat?"—no matter what age Henry may be.

Stephen Interviews Leacock

By Stephen Leacock: Canada's premier humorist describes what happened when he was interviewed on his arrival in London; tells how the English questions left him all at sea because he missed the usual "bromides."

A Startling Review

"Can the White Race Endure in the Bright Sunlight of Western Canada?" Charles H. Huestis, M.A., D.E., here discusses the effe of light and warmth on our Western people.

Twenty other reviews from British, French, American and Canadian current literature.

Is All Prayer Answered?—by Marshall P. Talling: A timely and entertaining article by a Canadian who has made a special study of prayer, what it means and what it achieves.

The Efficiency Christmas—by Zoe Beckley and Joseph Gollomb: A yuletide story with a laugh and a sob, a thrill and a heart-tug, about real people with the right sort of kiddies.

The Case of Jean Louis—by Maurice Le Blanc: The third of the Arsene Lupin series, by the master teller of fast-acting mystery tales.

The Ladies' Chain—by Alan Sullivan: A follow-up story on one of the most craftsmanlike pieces of fiction ever published in Canada, "Linen Sheets," which appeared a few months ago in MACLEAN'S.

The Usurper—By Archie P. McKishnie: The story about a lynx who was victorious in his battles with other savage things in the wilds and then challenged Man.

Pipes Over the Water—by Frances Beatrice Taylor: Three experienced journalists read this story before publication in MACLEAN'S and each voted it one of the most remarkable little stories of its kind he had ever read.

Mostly Sally—by Pelham Grenville Wodehouse: A big slice of the funniest thing which Wodehouse has written since "The Little Warrior."

The Yellow Streak—by Valentine Williams: The concluding instalment which unfolds the hidden-to-the-last secrets of this enthralling mystery story.

DECEMBER 1st ISSUE ON SALE TODAY AT ALL NEWS STANDS **20c**

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

Make Sure of Your Copy Now --- Get it Today

Or Send $3.00 for a Year's Subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto.

Columbia Recording Thermometers now made with the New Time Punch!

Columbia Recording Thermometers, equipped with this ingenious little device, enables you to check up accurately on the operator who is responsible for maintaining a uniform temperature.

The Day-and-Night Chart gives you a true record of temperature variations — but the TIME PUNCH shows whether or not the operator was watching the chart.

Columbia Recording Thermometers, Gauges and Tachometers are the only instruments fitted with this ingenious and highly valuable device. If you are interested in this equipment

Send Your Enquiries to Our Toronto Office

and get the benefit of our local service. A generous stock of standard instruments for the promotion of efficiency in the power plant and manufacturing departments will soon be placed there. Write for Catalogues, Prices and Technical information.

THE Schaeffer & Budenberg MFG. CO.

Brooklyn, N.Y.

Makers of Columbia Recording Thermometers and Gauges with TIME PUNCH

67-69 Frederick St., TORONTO

Phone Main 2578

Check the Dollars You Burn!

Do you know how many of the dollars you burn are actually invested in heat—and how many are wasted?

Of course you know how many tons of coal you buy. And you probably know how much heat that coal contains—you can get a B. T. U. analysis from any chemist. But do you know the amount of heat you get out of that same coal?

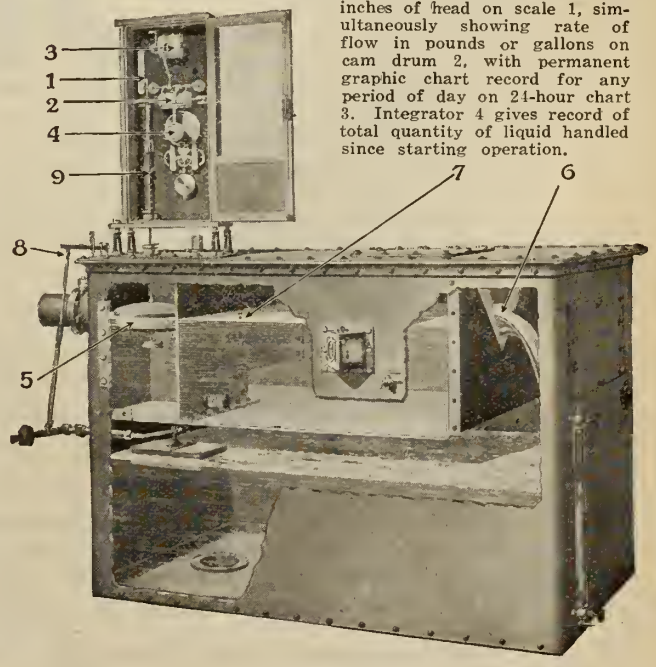
There is only one dependable way to calculate the value of your coal—what quantity of water is evaporated by a ton of it? A

YARWAY-LEA V-Notch METER

will give you the records you need to determine the degree of economy with which your boiler room is operated and will enable you to prove this to the management. It is a simple, durable, scientific machine, providing permanent records guaranteed accurate within 1½% at high and low rates of flow.

There are many other uses for the Yarway-Lea Meter besides in the boiler room. Booklet L-40 goes into details. Where shall we send your copy?

Operation: Liquid is admitted through control valve 8 to weir chamber 7. As level of liquid rises and falls, flowing through V-notch 6, float 5 connected to rackrod 9 also rises and falls, indicating flow in inches of head on scale 1, simultaneously showing rate of flow in pounds or gallons on cam drum 2, with permanent graphic chart record for any period of day on 24-hour chart 3. Integrator 4 gives record of total quantity of liquid handled since starting operation.



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YARWAY POWER PLANT DEVICES

Bright Spots In The Industrial Outlook

NO. 5

A LARGE business organization in the United States recently sent out a circular in which the following occurs: "No really live business man will follow the rest of the 'sheep' and say 'there is no business in my line.'

"There is business in every single line of industry today, barring none. True, in some lines the opportunities are less than in others, but there is absolutely no excuse for not getting your share."

This statement fairly "hits the nail on the head." If each manufacturer or merchant will realize that, no matter how dull business may be, there is at any rate enough business going to keep him fully employed, and if, realizing this, he will go after the business with every ounce of energy of which he is capable, he will not only be able to maintain his volume of sales at its normal level but will uncover fresh business which will enable him in spite of dull times to emulate the example of those merchants details of whose success in this respect we have already given, and to whose number we make a further addition below.

The Universal Knitting Co., Vancouver, has in the past twelve months doubled its floor space and doubled its capacity, and, according to Mr. A. C. Cohen, the manager, is employing more operatives than ever before. Full time has been worked all the year. The volume of garments manufactured and sold has been 50 per cent. greater than last year. The policy followed has been to make prices as close as possible but in no way to allow quality of goods to suffer.

The Williams Tool Corp., of Brantford, Ont., report that business last month was double that of the previous month and that they are doing much better business than a year ago. Asked to account for this, Leslie H. Hall, sales manager, said, "We know our machines were selling at a fair price, so we decided that more aggressive methods of salesmanship were required. We have spent considerable money on educational and advertising literature."

Bovril, Ltd., report that sales of Bovril in Ontario during 1921 show an increase of 75 per cent. over those of last year. Sir George Lawson Johnston, president, who was lately in Canada from the Old Country, stated that their sales throughout the world are ahead of last year.

Willards' Chocolates, Ltd., are considerably ahead of last year in their sales. Their returns for October show an increase of 32 per cent. over the same month last year. This they attribute to consistent advertising and hard work.

The King Suspender Co., Toronto, sold out their stock at sharply reduced prices last May. They then manufactured quickly and well with a low-cost material. A strong advertising campaign was launched and nearly the whole staff were sent on the road. The sales staff was increased as it was realized that, with dealers buying from hand to mouth more calls were necessary. The plant is working full time and two auxiliary plants in Toronto and two in Montreal are adding to the output. The company is two months oversold in neckwear and has not taken orders for three weeks. Business in dollars and cents during the past three months has been more than last year; while, owing to lower prices, the quantity of goods sold is twice as great.

The Sherwin-Williams Co. of Canada state that their business shows a substantial increase in turnover as compared with last year despite the fact that there has been approximately a 25 per cent. decline in paint prices. W. S. Fallis, vice-president, attributes this partly to more aggressive selling and the lower prices.

This experience is more or less that of the other paint companies who practically all report increases in volumes of sales although the cash receipts are not increased in proportion owing to the reduction in price. The success of those employed in this particular line of business is undoubtedly due in no small degree to the vigorous paint advertising campaigns which have been organized by the manufacturers.

The Supplee-Biddle Hardware Co., of Philadelphia, with the help of advertising and increased selling effort and by turning the office staff to selling, have more than maintained the volume of sales. In 1920, says W. B. Munroe, president and general manager of the company, business was greater than it had ever been, and December completed the 63rd consecutive month of increased sales. This year the total volume of sales will exceed last year with a volume in dollars that is nearly 24 per cent. greater than any year except 1920. All this business has been gained by hard, persistent sales effort and can be directly traced to ideas which had their inception in the office among the so-called "non-producers." Every part of our organization became a selling unit from the president on down to the youngest office boy.

You can send your sales message throughout Canada from Coast to Coast by means of the following MacLean publications, all of which are members of the Audit Bureau of Circulations. Information regarding circulation, advertising rates and fields covered will be furnished on application.

The MacLean Publishing Co., Ltd., 143-153 University Ave., Toronto

PUBLISHERS OF:

The Financial Post
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Canadian Foundryman
Druggists' Weekly
Power House
Canadian Motor and Implement Trade Journal
Marine Engineering
Printer and Publisher
Sanitary Engineer
MacLean's Magazine
Farmers' Magazine

"A Valve in the Line is worth Two Under Repair"

Unless a valve is positively dependable and will remain tight for long periods without attention it represents a poor investment.

Pratt & Cady Renewable Valves are a worth-while economy in times where every effort is made to reduce the cost of doing business. When after long hard service or because of scale, or other similar substances in the line, leaks develop, the worn parts can be repaired without removing the valves from the line and in minimum time.

Gate valve wedges are reversible and the discs of globe, angle and check valves, as well as seat rings in all types of valves, are renewable. No tool more complicated than a spanner wrench is needed to make the replacement.

Pratt & Cady Valves are economical in both first and final cost. You cannot afford to instal any other kind.

PRATT & CADY

GATE-GLOBE & SWING CHECK VALVES

PRATT & CADY CO., INC.
Factory: Hartford, Conn.

THE CANADIAN FAIRBANKS-MORSE COMPANY Limited.

Halifax, St. John, Quebec, Montreal, Ottawa, Hamilton, Calgary, Saskatoon, Windsor, Winnipeg, Vancouver, Victoria.

PLIBRICO

For Complete Linings

If your furnace linings had been made of **PLIBRICO** there would not have been such an advance in your Fuel Bills, since the weather got cold.

Re-line with PLIBRICO and pocket the saving.

Do it during the holidays.

Your own men can do the job.

Write for Particulars

Beveridge Supply Co. Ltd.

628-630 St. Paul St. West
MONTREAL

Stocked in Toronto and Western points

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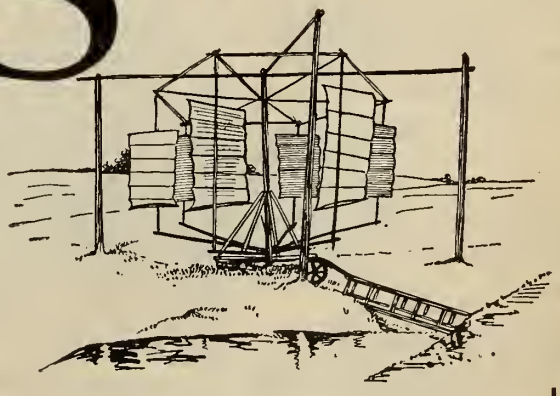
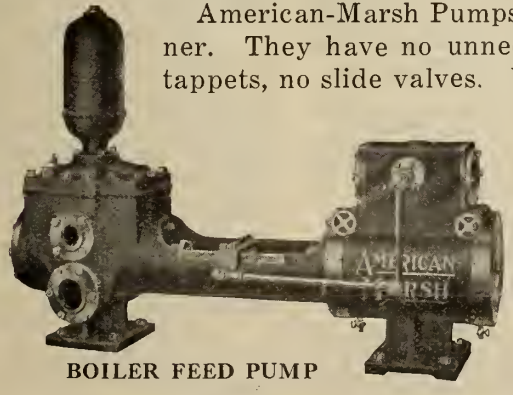
The ancient Chinaman didn't believe in doing anything he could get natural forces to do for him. In this peculiar windmill pump—for pumping salt water—the wind drives the mill, the mill drives the pump, and the sun does the rest, by drying out the salt. In this way, the Chinese "manufactured" great quantities of salt in a very cheap way.



American-Marsh Pumps are economical—in a modern scientific manner. They have no unnecessary parts—no internal stuffing boxes, no tappets, no slide valves. Write for Bulletins.



BOILER FEED PUMP

AMERICAN STEAM PUMP CO.
Battle Creek, Mich.

Chicago Office:
1220 Monadnock Block

New York Office:
17 Battery Place

The American-Marsh line also includes Centrifugal Pumps, Power Pumps, Air Compressors, Vacuum Pumps, Condensers, Deep Well Engines.

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Penberthy Injector Co., Windsor, Ont.
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American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto.
Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co.

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Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

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Canadian Johns-Manville Co. Ltd., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

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ARCHES, BOILER AND COMBUSTION
Jointless Fire Brick Co., Chicago, Ill.

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Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
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Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York. N.Y
Garlock Packing Co., Hamilton, Ont
R. C. Miller Oil & Supply Co., Ltd., Montreal.

ASBESTOS PACKED COCKS
Beldam Asbestos (Canada) Co., Toronto.
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co., Windsor, Ont.

BALATA BELTING
W. J. Brown (Tucks), Montreal.

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R. C. Miller Oil & Supply Co., Ltd., Montreal.

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D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

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W. B. Sexton Co., Toronto.

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Taylor Instrument Co., Toronto, Ont.

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Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

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Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

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Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co. Toronto.
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Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

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R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

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Can. Consol. Rubber Co., Ltd., Montreal.
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Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

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Gutta Percha & Rubber Co., Limited.

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Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
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Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

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Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

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Can Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Philip Gies Foundry, Kitchener, Ont.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

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The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevent Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
C. B. Turner, Toronto.

BOILERS
Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal
C. B. Turner, Toronto.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

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Sexton Boiler Setting Co., W. R., Toronto
C. B. Turner, Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
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Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER LINING, PLASTIC
C. B. Turner, Toronto.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome,

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
Philip Gies Foundry, Kitchener, Ont.
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

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Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

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Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

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Can. Mead-Morrison Co., Ltd., Montreal.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

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Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

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International Chemical Co., Toronto, Ont.
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The Mason Regulator & Eng. Co., Ltd. Montreal.

Speed, Safety and Durability

These are the characteristics of YALE SPUR GEARED CHAIN BLOCKS that make them popular in power plants.

Big fellows for placing machinery in position and little fellows for lighter work, are all made on the same high standard. With a continuous hand chain guide, the hand chain won't gag or foul from side pull or high speed.

YALE Blocks will give you service.

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either plain or geared should be used with a YALE chain block.
Small sizes with bronze bearings, two ton and over with roller bearings and with four wheels set at the correct angle. An easy running, safe, durable trolley and fit to be used with YALE chain blocks.

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Packed Piston Type for Medium Pressures

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Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
E. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

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Mueller Mfg. Co., H., Sarnia, Ont.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

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Can. Link-Belt Co., Toronto, Ont.
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Mackinnon Steel Co., Ltd., Sherbrooke, Q.
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Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
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Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

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Jamison Cold Storage Door Co., Hagerstown, Md.

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Laurie & Lamb, Montreal.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.

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Dart Union Co., Ltd., Toronto, Ont.

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J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal

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Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
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Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
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Smart-Turner Machine Co., Ltd., Hamilton

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CRANES, PORTABLE
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CRANES, SWING JIB
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DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

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MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

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Goldie & McCulloch Co., Galt.
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MacKinnon Steel Co., Sherbrooke, Que.

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Leonard & Sons, Ltd., E., London, Ont.
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Crane's Limited, Montreal.

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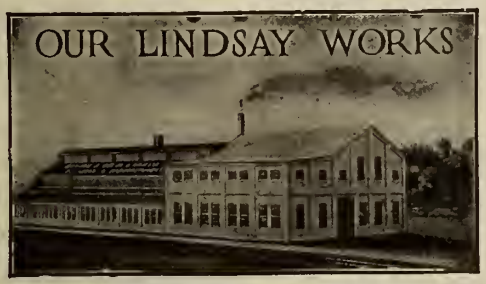

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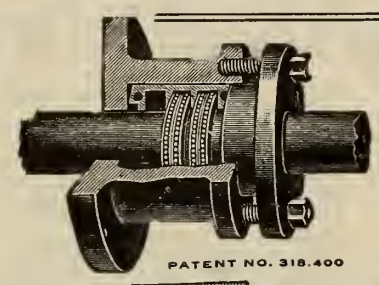

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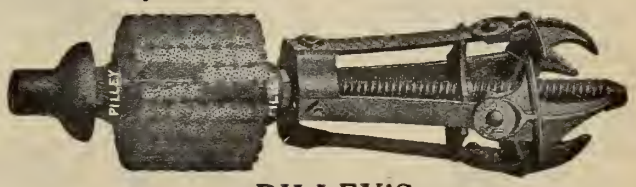

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Mueller Mfg. Co., Ltd., The.

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Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Taylor Instrument Co., Toronto, Ont.

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Dominion Flow Meter Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto

METERS (OIL, KEROSENE, GASOLINE, ETC.)
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METER TESTERS
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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd. Montreal.
Waterous Engine Works Co., Brantford.

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Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
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E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
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Lunkenheimer Co., Cincinnati, Ohio.

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Superheater Co., Ltd., The, Montreal
Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

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Fig. 106
JENKINS
BRASS GLOBE VALVE

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There's a Jenkins Valve for every Service. Supply Houses everywhere sell them. Look for the Diamond Trade Mark when buying—it guarantees the genuine.

Catalog No. 8 free on request.

Fig. 402
JENKINS
STANDARD GATE VALVE
TYPE "K"

Fig. 141
JENKINS
IRON BODY GLOBE VALVE
With Yoke

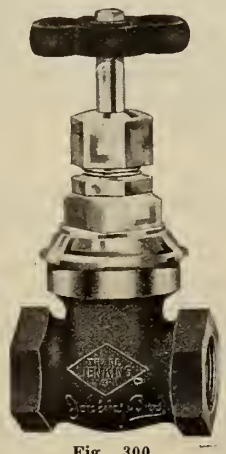

Fig. 300
JENKINS
BRASS GATE VALVE
TYPE "K"

Fig. 500
JENKINS
STERLING E. H. BRASS
GLOBE

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Canadian Johns-Manville Co. Ltd., Toronto.
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Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply, Ltd., Toronto.

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PAINTS
Shell Bar Bolco Supply, Ltd., Toronto, Ont.

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York Mfg. Co., York, Pa.

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MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.

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Darling Bros., Montreal.
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Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Pratt & Cady, Hartford, Conn.
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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
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Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

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Pratt & Cady, Hartford, Conn.
Pratt & Cady, Hartford, Conn.

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S'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton
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Smart-Turner Machine Co., Hamilton.

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Smart-Turner Machine Co., Hamilton.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

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Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

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Darling Bros., Montreal.
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Laurie & Lamb, Montreal.
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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Laurie & Lamb, Montreal.
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Pratt & Cady, Hartford, Conn.
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Taylor Instrument Co., Toronto, Ont.

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Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

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Taylor Instrument Co., Toronto, Ont.

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Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

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Lincoln Electric Co. of Can., Ltd., Toronto

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Gelinas & Pennock, Reg'd, Montreal.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
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Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

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Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

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The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

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Penberthy Injector Co., Windsor, Ont.

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Canadian Johns-Manville Co. Ltd., Toronto.

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Waterous Engine Works Co., Brantford.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

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York Manufacturing Co., York, Pa.

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York Manufacturing Co., York, Pa.

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Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

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S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Babcock & Wilcox, Ltd., Montreal.
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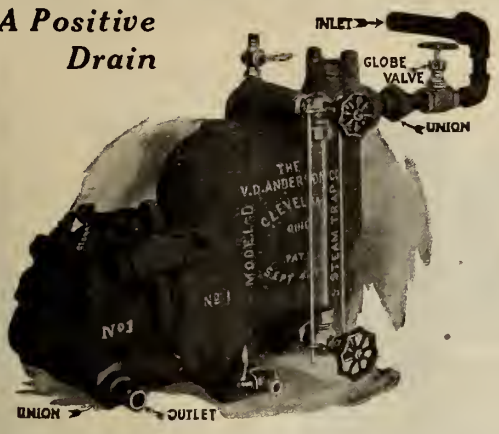

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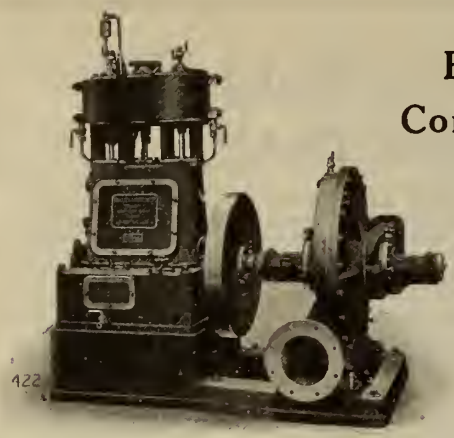

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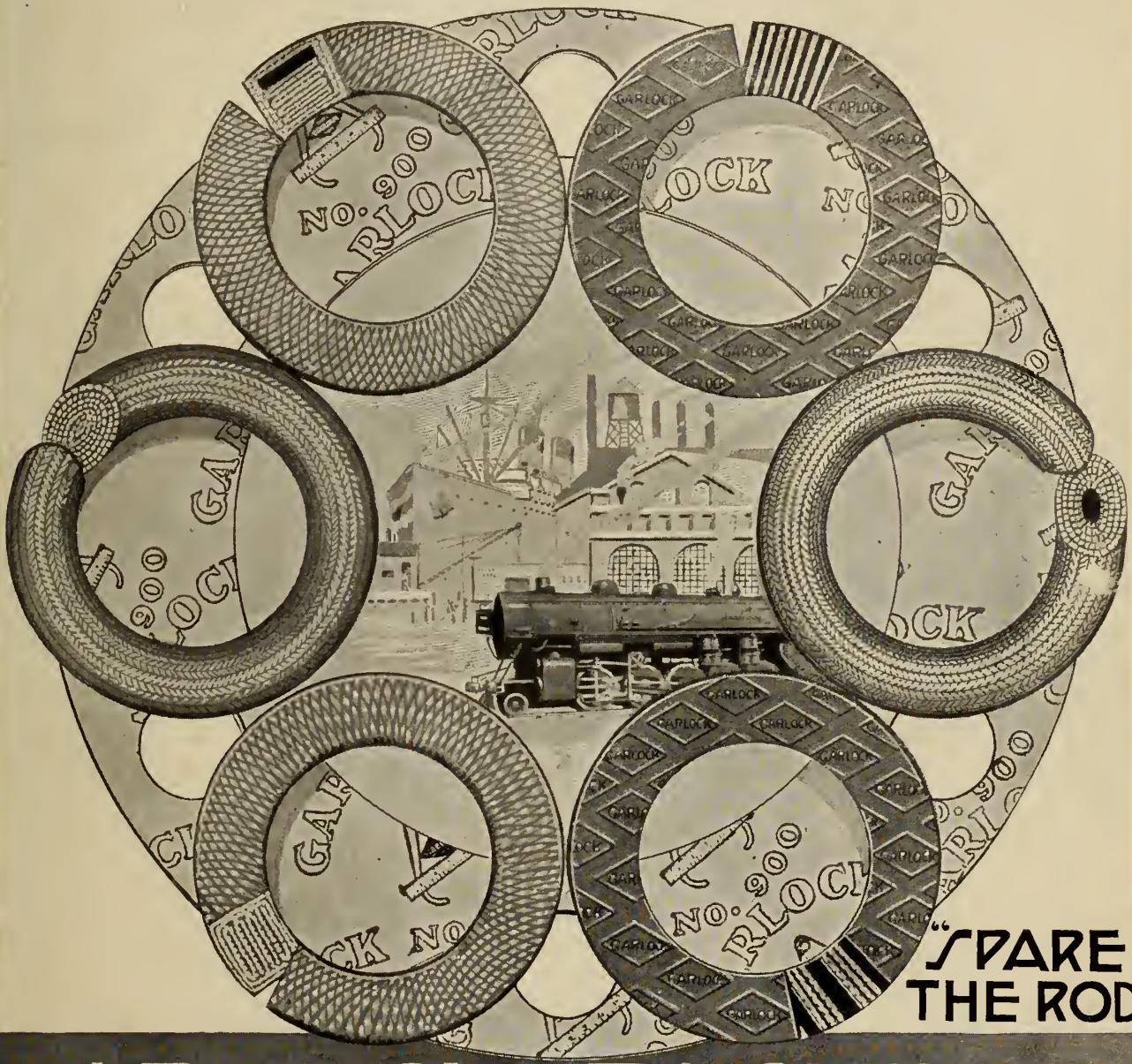

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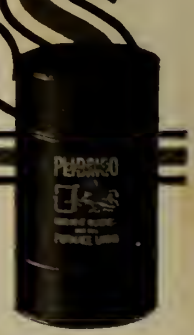

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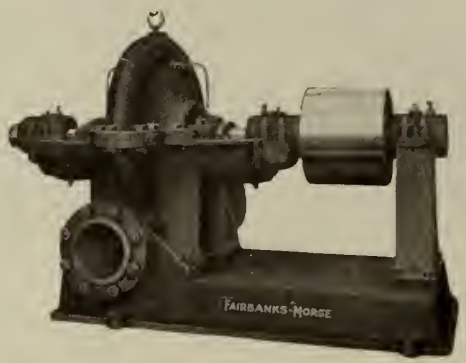

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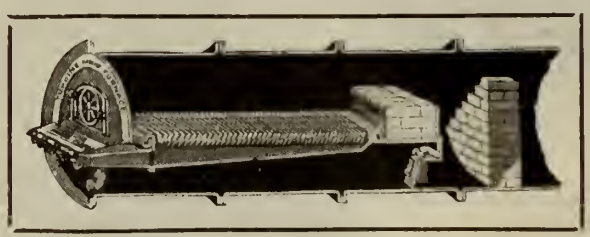

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Tanks — Boilers — Engines — we have a great variety of practically as good as new equipment at prices that can't be duplicated anywhere. *Real bargains* everyone! Vertical, Horizontal and Firebox Boilers. Marine Internal Fired Automatic Engines; also Vertical and Horizontal Engines. Compare our values! Write for prices

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LIMITED
TORONTO and HAMILTON

The P.A. sees the I.O.S.

IMPERIAL Lubricants

FOR MANUFACTURING MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
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Imperial Solar Red Oil
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The Imperial Oil Salesman is warmly welcomed by the Purchasing Agent who follows the profitable policy of buying ***correct lubrication***, rather than ***just oil.***

Imperial Lubricants insure proper lubrication with a grade of oil or grease for each particular plant requirement. All grades are equally high in quality, equally efficient and economical. Their regular use increases plant profits while reducing many items of overhead expense.

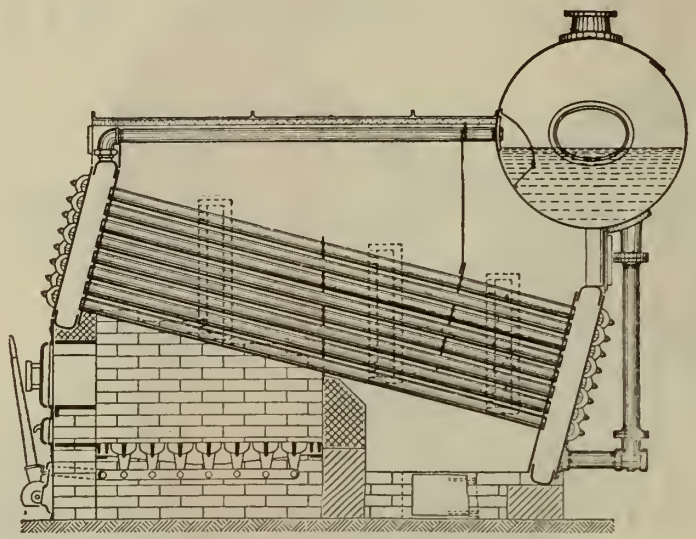
Our expert Engineering Department is maintained to assist you with lubrication problems. Write to 56 Church St., Toronto.

IMPERIAL OIL LIMITED

Canadian Company—Canadian Capital—Canadian Workmen

Branches in all Cities

The Victory Heating Boiler



Is a water-tube boiler designed for heating, and is the safest boiler that can be used.

It has a steel case lined with asbestos and firebrick and requires no brick setting.

It may be shipped knocked down and taken into a building through ordinary doors.

Robb Engineering Works, Limited - - Amherst, N. S.

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Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA

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Strength; Goodness; Quality - these features distinguish Durabla Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points.

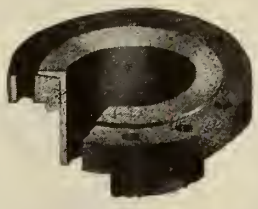
Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

DURABLA MANUFACTURING CO., NEW YORK

Distributors in Canada: The Canadian Fairbanks-Morse Company Limited

DURABLA



No. 181D. Granelap Joint with Cast Steel or Forged Steel Flange

No. 281D Screwed Joint with Cast Steel or Forged Steel Flange

CRANE

EXTRA HEAVY

No. 295E. Craneweld Joint with Forged Steel Flange.

FLANGED PIPE JOINTS

WITH CRANE CAST STEEL AND FORGED STEEL FLANGES.

Cranelap Flanges are highly recommended for use in connection with pipe bends.

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

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37

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., **Toronto**

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec
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Dominion Belting Company, Limited

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Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting. leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal

Fisher Tank Controller
(Type 27)

Accurate Level Control For Your Storage Tanks

Any desired level of liquid in your tanks or reservoirs may be accurately maintained with the

Fisher Tank Controller
(Type 27)

It is built for use on closed tanks. It consists of a Fisher Balanced Lever Valve, connecting rods with turnbuckle, bell crank, stuffing box and seamless copper low-pressure float.
It can be used in numerous ways. It will control steam supply to pump according to accumulation of condensation in receiver tank. It will control pump so as to maintain a certain level in tank and it can be installed on waterline to control water level in tank or the outflow where tank is discharging independently into sewer or against no pressure.

Fisher Float Valve
(Type 17)

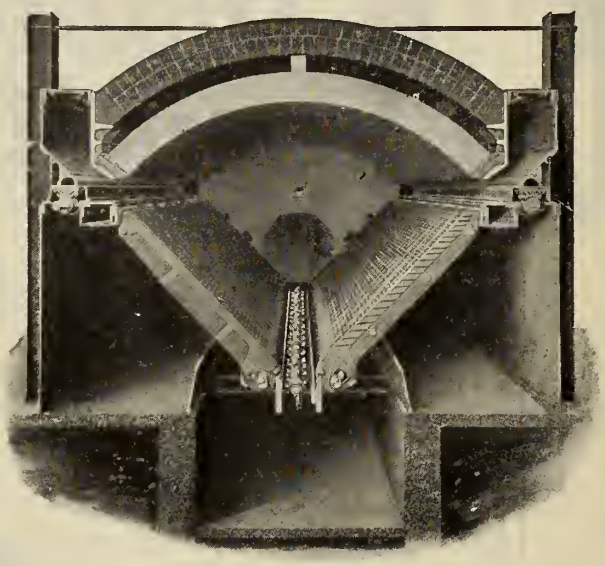
is an automatic valve especially designed for open tank purposes. Made of the highest grade materials and with characteristic Fisher accuracy and fineness of workmanship, it will render perfect service for unbelievably long periods of time.

Bulletin 401 contains complete information and installation sketches of these devices. Write for your copy to-day.

THE FISHER GOVERNOR Company
928 Fisher Avenue, Marshalltown, Iowa
Agencies in all Principal Cities

FISHER
TRADE MARK REGISTERED

MURPHY AUTOMATIC FURNACES



For Any Boiler
50 h.p. and Up

Any boiler from 50 h.p. and up, can be equipped with the MURPHY FURNACE. The **smaller plant** can therefore enjoy all the economical advantages of fuel and labor savings **without resorting** to forced draft.

To-day over **6000 boilers** are fired by MURPHY FURNACES. You will find them used in nearly every branch of the industry from hospital to industrial and central station service. MURPHY FURNACES "burn any fuel that has heat in it." They double the output of the plant "without one penny for draft."

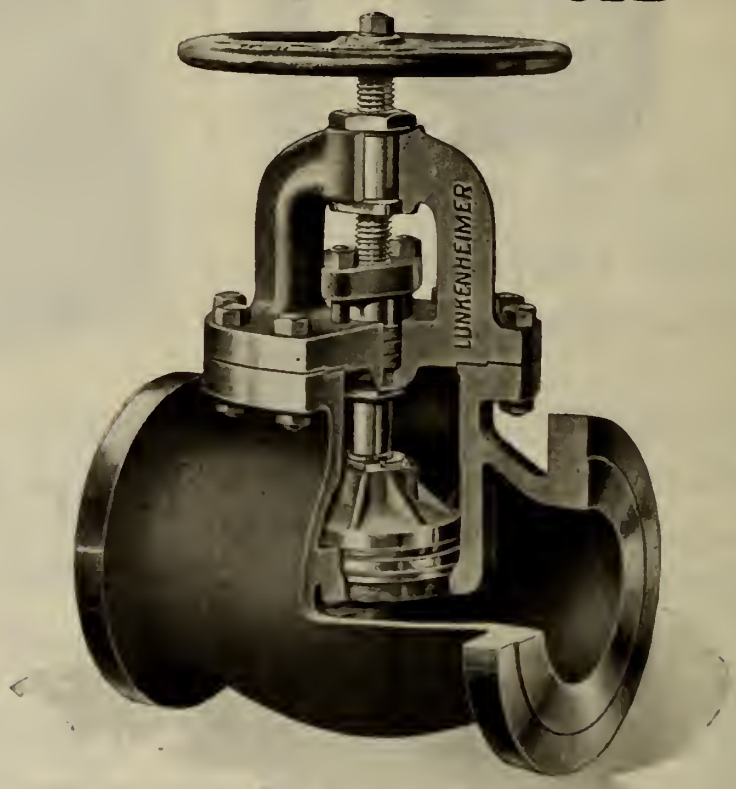
Our Catalogue "HM-12" shows how MURPHY FURNACES can be installed under any type of boiler—50 h.p. and up.

For information on RILEY UNDERFEED STOKERS for large boilers see December 5th advertisement or send for RILEY STOKER Catalogue "HR-12",

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

LUNKENHEIMER

Globe, Angle, Cross and Check Valves



Extra Heavy, Fig. 884.

Standard, Fig. 1123.

Service economy—long life with a minimum cost for upkeep—is the dominant factor which has led to the selection of LUNKENHEIMER Iron Body Valves as "standard equipment" in many leading plants.

Their success in service is the direct result of the combination of correct design with proper materials and the Lunkenheimer method of manufacture.

LUNKENHEIMER "Valve-iron" and Lunkenheimer "Valve-bronze" are formulated especially for valve service and the Lunkenheimer method of manufacture insures dependable results under prescribed operating conditions.

The line embraces a variety of types and sizes in Standard and Extra Heavy Patterns for pressures up to 125 and 250 pounds respectively, whose performance and durability fully measure up to the Lunkenheimer high quality standard.

There is a LUNKENHEIMER Distributor in every commercial center ready to give prompt service. Specify LUNKENHEIMER Iron Body Valves and insist on getting what you specify.

THE LUNKENHEIMER CO.

"QUALITY"

LARGEST MANUFACTURERS OF
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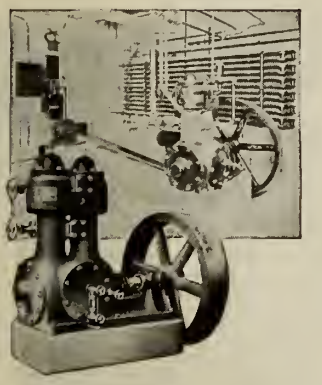
A YORK MACHINE

does not require a skilled operator



DON'T get the impression that Mechanical Refrigeration means complicated apparatus, difficult to understand and costly to operate. You need have no such fears if it's a YORK installation.

A York plant is the embodiment of simple efficiency. No skilled attendant is required. One of our customers says in testifying to the simplicity of his York plant, "It is being operated successfully by an employee who, prior to the installation of the machine, had never seen one nor had any experience in operating one."

Constant attention is unnecessary. The simple regulation of one valve gives any degree of cold you want—freezing, zero, below zero—whatever your business needs may require.

If you want the simplest, most efficient, most economical refrigerating system, you will investigate the York Refrigerating Plant.

Canadian Representative:

CANADIAN ICE MACHINE COMPANY
TORONTO: Villiers and Munition St., Eastern Harbor Terminals
MONTREAL .....324 Craig St. West
WINNIPEG.....85 Lombard St.

YORK MANUFACTURING COMPANY

(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA., U.S.A.

FOR REFRIGERATING EQUIPMENT

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P⊗H WROUGHT PIPE

GENUINE WROUGHT IRON ∴ STEEL
LAPWELD ∴ BUTTWELD

SPECIAL REDRAWN PIPE for AMMONIA PURPOSES

WROUGHT PIPE BENDS
ALL KINDS AND SIZES

FLANGED PIPE JOINTS
ALL TYPES

MADE IN CANADA BY

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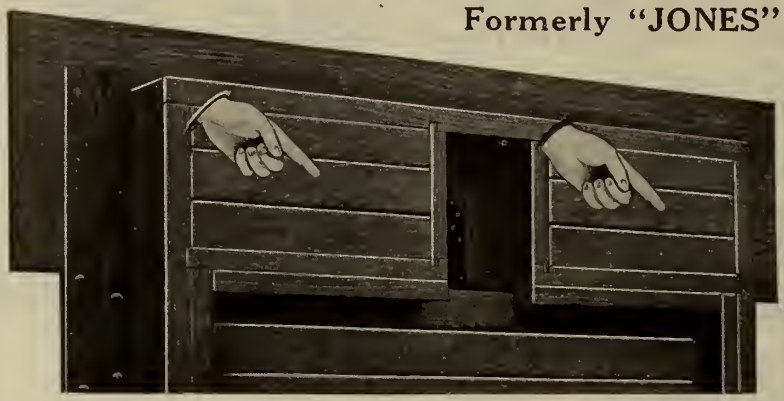
Incomparable JAMISON

Formerly "JONES"

Heavy Duty Cold Storage Doors



Have Many Points of Superior Construction

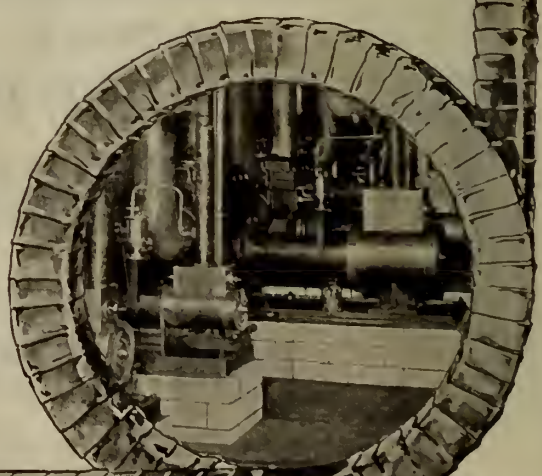
Note the back of our Standard Track Head Frame with track part; we insulate and finish our track frame heads, an unusual feature. Then note the simplicity of the Track Lift device over the door; no springs or other delicate parts to get out of order. Our Automatic Self-tightening Fastener draws the door rigidly tight each time it is slammed. The hinges too are three to five times heavier than other makes.
These features, and many others, are fully explained in catalog No. 10. Write for it.

JAMISON COLD STORAGE DOOR CO.
Formerly Jones Cold Store Door Co., HAGERSTOWN, MD., U.S.A.

John Crane

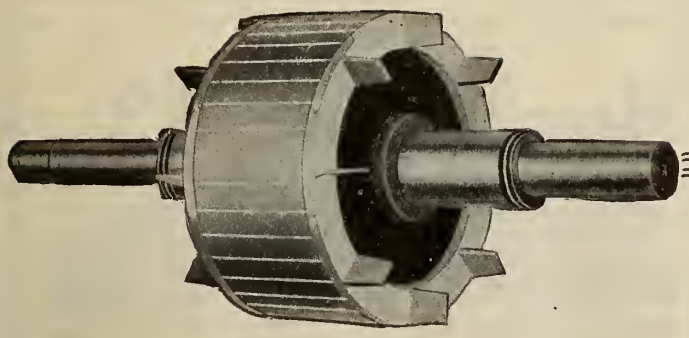
Eight Years of Packing Service
JOHN CRANE Flexible Metallic Packing Shows Greatest Results in Constant Service

Eight years ago Chief Engineer, N. Gross, of the Standard Oil Building, Chicago, installed JOHN CRANE Flexible Metallic Packing in the boiler-feed pump pictured below. Mr. Gross reports packing and pump in good order after eight years and has standardized JOHN CRANE on all service.
JOHN CRANE holds this long service record because of its scientific, practical construction. Made of babbitt foil and graphite, it brings Packing science "The Babbitt-bearing Principle," and while responding to the slightest pressure of the gland never dries out, but remains compressible and will not score rods.



Write for your copy of "THE ANSWER" a book that tells unusually interesting things about packing problems

The R. C. MILLER OIL & SUPPLY CO.
38 & 40 YOUVILLE SQUARE, MONTREAL



No Soldered Joints or Bolted Connections in--

Canadian Crocker-Wheeler Rotors

¶ The greatest improvement in modern induction motor design—no soldered joints to melt and cause arcing or open circuit and no bolted connections to work loose.

¶ The entire Rotor Winding of small squirrel-cage induction motors is cast of aluminum alloy — in one operation. Thus, the complete winding is one integral structure.

¶ The medium and large size Rotors have liberal section copper bars and the end rings are cast-welded, making perfect contact.

In stock at our houses, who will furnish full technical data on request.

Northern Electric Company
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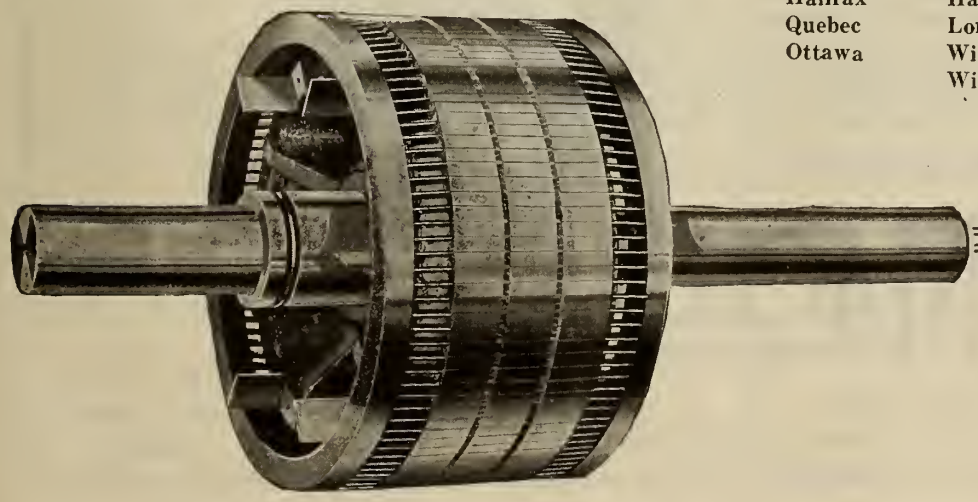

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Fifteen of the Best Sellers of the Year For $3 if you subscribe to MacLean's Magazine

During 1921 MACLEAN'S, Canada's National Magazine, has published the whole or major portion of the following fifteen books, which have since been published in book form—or are shortly to be published:

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—Col. George H. Ham
The recollections of Canada's premier story teller, the C.P.R.'s knight of wit and wisdom, who has known every person worth knowing in Canada during the past half century.

(2) Masques of Ottawa—"Domino"
A series of brilliant, biographical sketches of Canadians prominent in politics and business; analogous to "The Mirrors of Downing Street."

(3) Canada at the Cross-Roads
—Agnes C. Laut
A series of vigorous, inspirational articles showing how Canada is standing on the threshold of nationhood; constructive criticism indicating how full national status is being achieved.

(4) Policing the Plains
—Rev. R. G. MacBeth
The latest and most authoritative history of the Royal North West Mounted Police, by a padre who himself took part in the Riel Rebellion and has associated with many of the leading characters in Canada's famous frontier force.

(5) The Drama of Our Great Forests
—Arthur Heming
The pulsating, throbbing, human-interest story of Canada's great northern fastnesses, told by the man who will go five hundred miles to get a fact; authentic, enthralling.

(6) The City of Peril—Arthur Stringer
An up-to-date narrative of a Bolshevistic plot which was nipped in the bud by an adventurous young millionaire; including a delightful Stringer-like romance.

(7) Pawned—Frank Packard
A fast-moving story of a triple regeneration, shifting wth kaleidoscopic speed from the South Sea Islands to this continent—novel, intense, gripping, mystifying.

(8) The Valley of Gold—David Howarth
The first novel from the pen of an athletic Methodist parson now resident in Miami, Manitoba—a true-to-life account of the Qu'Appelle Valley of Saskatchewan as it was twenty years ago; vigorously, thoroughly Canadian.

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—Pelham Grenville Wodehouse
A worthy successor to "The Little Warrior," told in the inimitably facetious and whimsical vein of this English master-craftsman.

(10) The Yellow Streak
—Valentine Williams
The story of a murder mystery solved by real human beings; from the pen of the author who wrote "The Man With the Club Foot."

(11) The Gates of Tien T'ze
—Leslie Howard Gordon
An enthralling book which ran in MACLEAN'S as a five-part serial; dealing with life in London when Anglo-Saxons and Chinese met at cross purposes.

(12) Lenix Ballister, Diplomat
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A dozen short stories about the typical Canadian negro of Western Ontario; a forthcoming volume from the pen of one of Canada's foremost fiction writers.

(13) Prince Renine—Maurice Le Blanc
Eight more stories in which the leading character is the thinly disguised Arsene Lupin, one of the world's famous characters in detective fiction.

(14) A Series of Short Stories
—"Sapper"—H. C. McNeile
Ten or a dozen brilliantly written stories, impregnated with human interest, from the pen of one of the most successful English authors brought to the fore during the war.

(15) The Man Who Knew Too Much
—G. K. Chesterton
A collection of eight stories, each with its distinctive mystery, and containing the usual Chestertonian twist, from the pen of the man who wrote the "Father Brown" series.

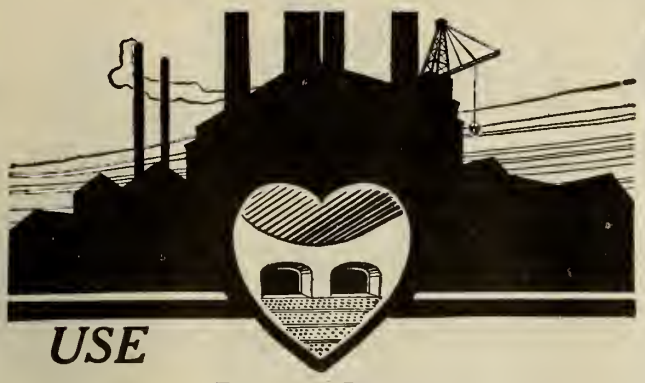
Readers of MACLEAN'S got all these books in 1921—ten books of fiction and five of a more serious character, biographical, reminiscent, political—permanent literature.

In addition, they got a most attractive offering of the best short stories and the twice-a-month Review of Reviews department, which kept them posted on current topics and developments in all parts of the world, as well as the multitude of Special Articles on Topics of National Interest in Canada, which have made MACLEAN'S something more than a magazine—a National Institution.

MACLEAN'S readers got all this immense value in 1921—in 1922 they will get bigger value still. And you get all this for $3.00—the price of a year's subscription—24 twice-a-month issues of

MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"

The MacLean Publishing Co., Limited, 143-153 University Avenue - Toronto



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BETSON'S
REG. U.S. PAT. OFF. TRADE MARK
PLASTIC FIRE BRICK

IN THE HEART OF YOUR PLANT

Build permanent, properly flared, one-piece boiler arches and walls without any bricks to fall out. Betson's Plastic Fire Brick eliminates frequent shut-downs for repairs, prevents inleakage of cold air. Any man can build one-piece arches and make perfect furnace linings with Betson's Plastic Fire Brick.

Write for informative booklet
for boiler room use

Betson Plastic Fire Brick Co., Inc.

P.O. Box 386-6, Rome, N.Y.

Canadian Distributors: INTERNATIONAL CHEMICAL CO.
44-6 Lombard Street, Toronto, Ont., Canada

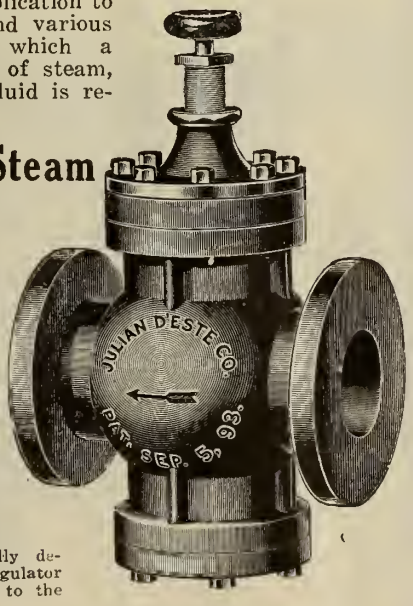
If it isn't BETSON'S it isn't Plastic Fire Brick

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal; is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

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Main Office, 26 Canal St., Boston, 41, Mass.

Agencies: { 180 WASHINGTON ST., NEW YORK CITY.
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Comparative Draft Readings

Made Easy!

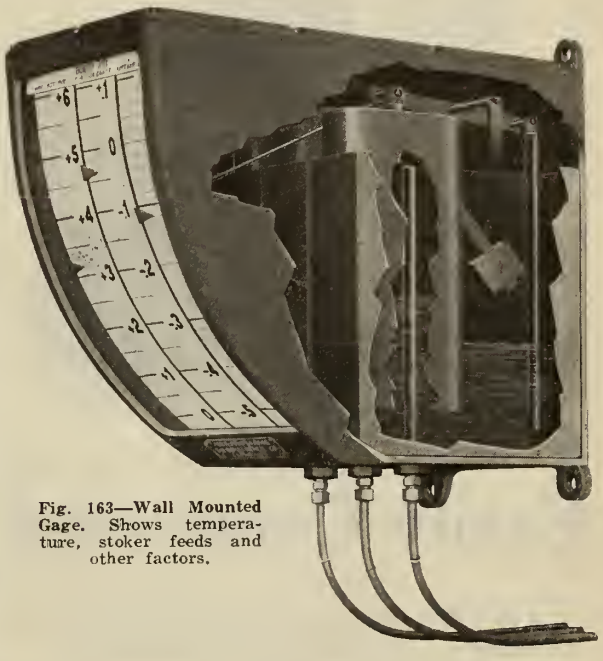

Fig. 163—Wall Mounted Gage. Shows temperature, stoker feeds and other factors.

BAILEY

Multi-Pointer Gages

The average engineer or fireman is only too well acquainted with the problems—too much time, inaccuracy, unreliability — that accompany old methods of comparing draft readings.

To these men we offer the **BAILEY Multi-Pointer Gage** as a new and accurate solution.

This reliable instrument is made to accommodate any required number of separate pointers so that all drafts can be recorded. Two distinct types of casing are used. One for wall mounting—the other for meter board. The figures can be easily read at a distance of 20 feet.

May we send Bulletin No. 160 ?

BAILEY Meter Company

2001 E. 46th Street, Cleveland, O.

Dart Union Pipe Couplings will not leak

Easily Connected

The Face and Seat being Ball-Shaped permits easy and perfect connection even if pipes are out of alignment.

All threads are exact to standards and are clean and full.

Dart Unions are made in a variety of styles to fill all requirements.

Bronze meets Bronze at the joint, a feature that removes all possibility of deterioration at the vital parts.

Will Never Wear Out

The Heavy Iron Parts will not stretch or pull apart, or become distorted when connecting up with a pipe line.

Sold by all Jobbers

Manufactured by

DART UNION CO., LIMITED

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Announces that the eighth annual

BRITISH INDUSTRIES FAIR

Will be held at

LONDON and BIRMINGHAM

from

27th February to 10th March, 1922

All Canadian buyers are cordially invited to attend.

A particularly fine and comprehensive range of

Mill Furnishings, Lighting Plant and General Machinery

will be shown in addition to many other lines of manufactured goods.

Goods can be examined, values compared and contracts concluded at the Fair with the minimum of trouble and the greatest saving of time.

Full Information and Complimentary Admission Cards are obtainable from:-

H. M. Senior Trade Commissioner
248 St. James Street, Montreal.

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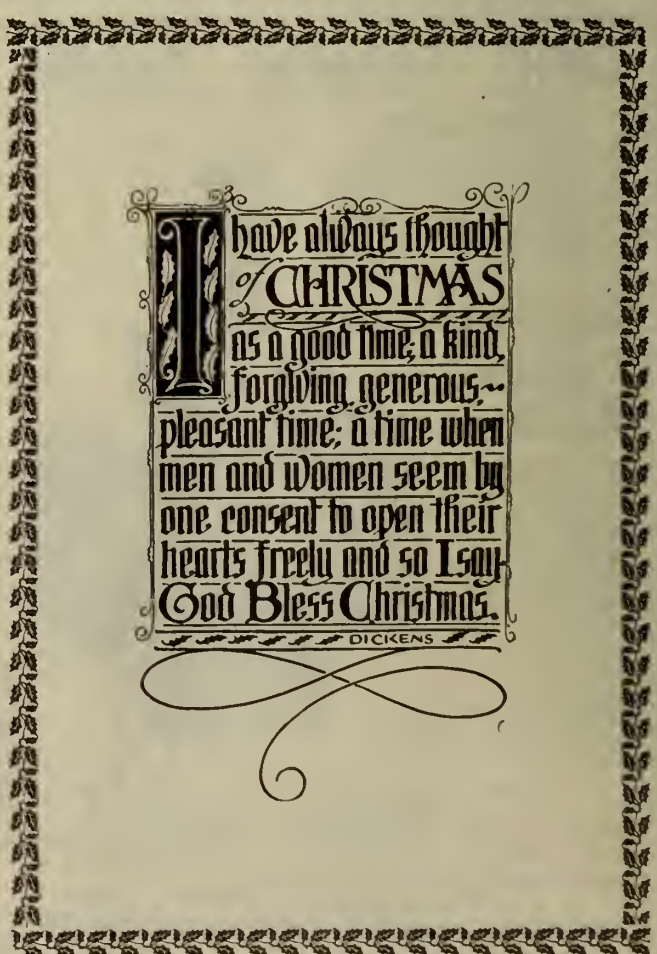
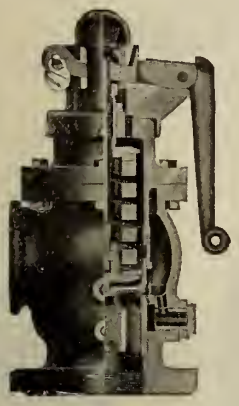
260 Confederation Life Building, Toronto.

H. M. Trade Commissioner
610 Electric Railway Chambers, Winnipeg.


I have always thought of CHRISTMAS as a good time; a kind, forgiving, generous, pleasant time; a time when men and women seem by one consent to open their hearts freely and so I say God Bless Christmas.
DICKENS



Ashton Pop Safety Valve

The Ashton

Sets the standard by which all

Safety Pop Valves

are judged

THIS valve holds a unique reputation. It is adopted by a government; it is recommended by prominent engineers; it has behind it a record of over forty-five years of leadership. Made in all sizes: 2 in. to 6 in. inclusive, complete with many patented improvements.

Ashton No. 7 Safety and Relief Valve

Our nearest agency will supply you with:
Mason Standard Reducing Valves
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Up-to-date Equipment of all kinds.

Write Our Nearest Branch for Full Particulars.

For Steam and Air ½" to 3" sizes.

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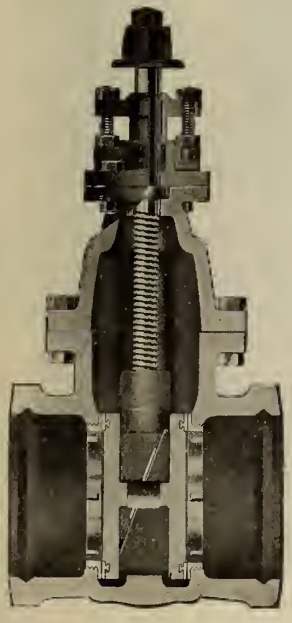

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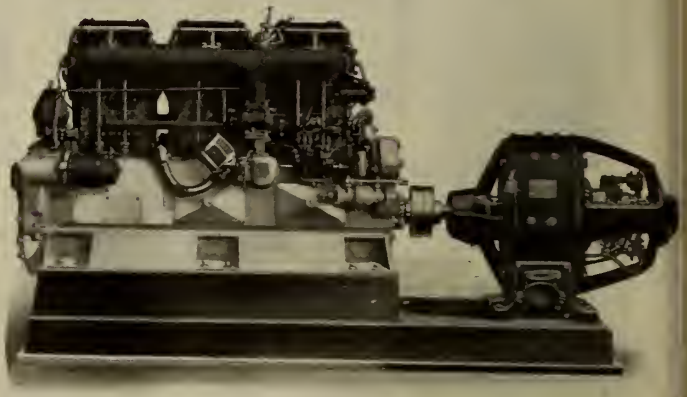

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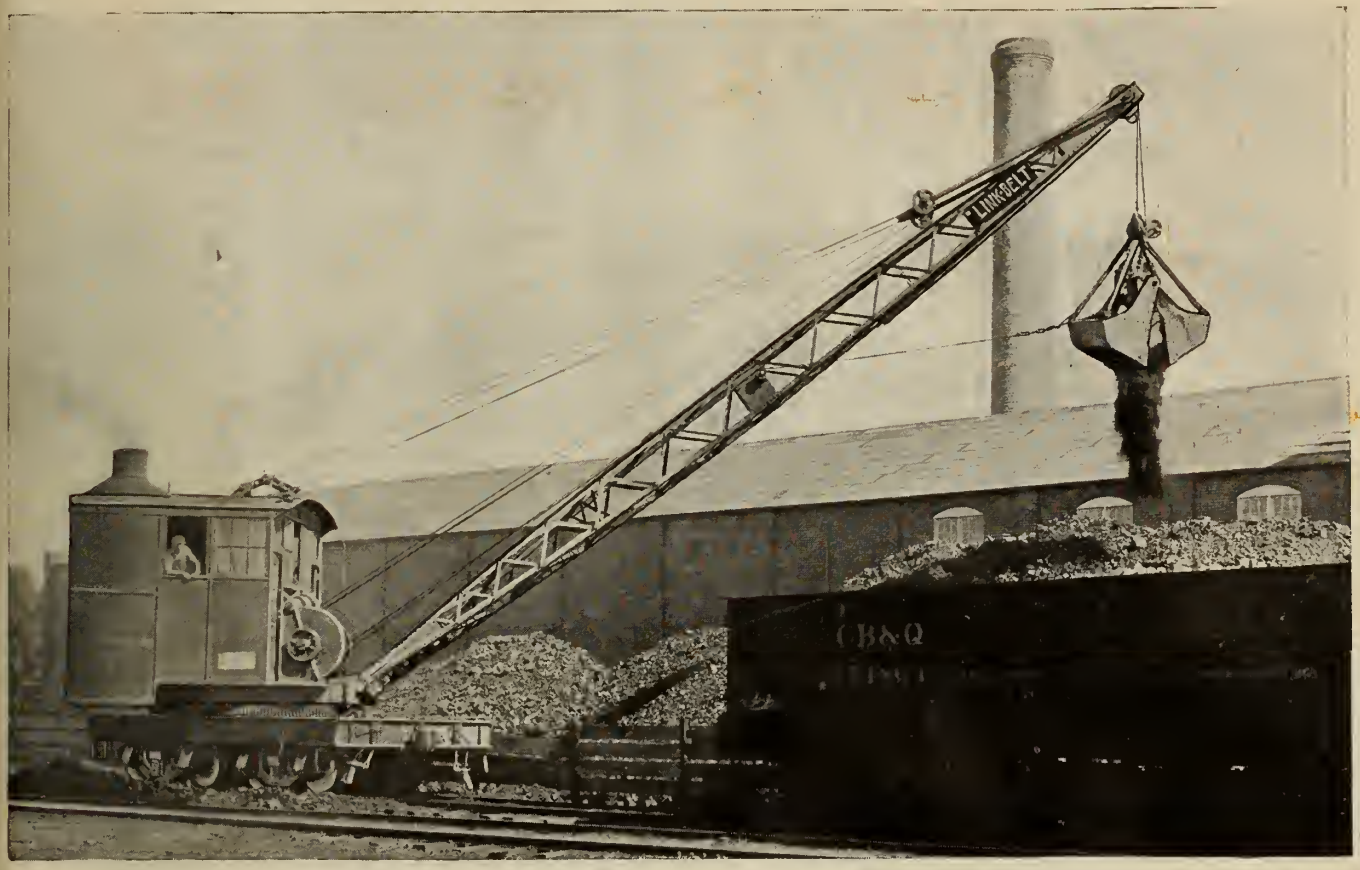

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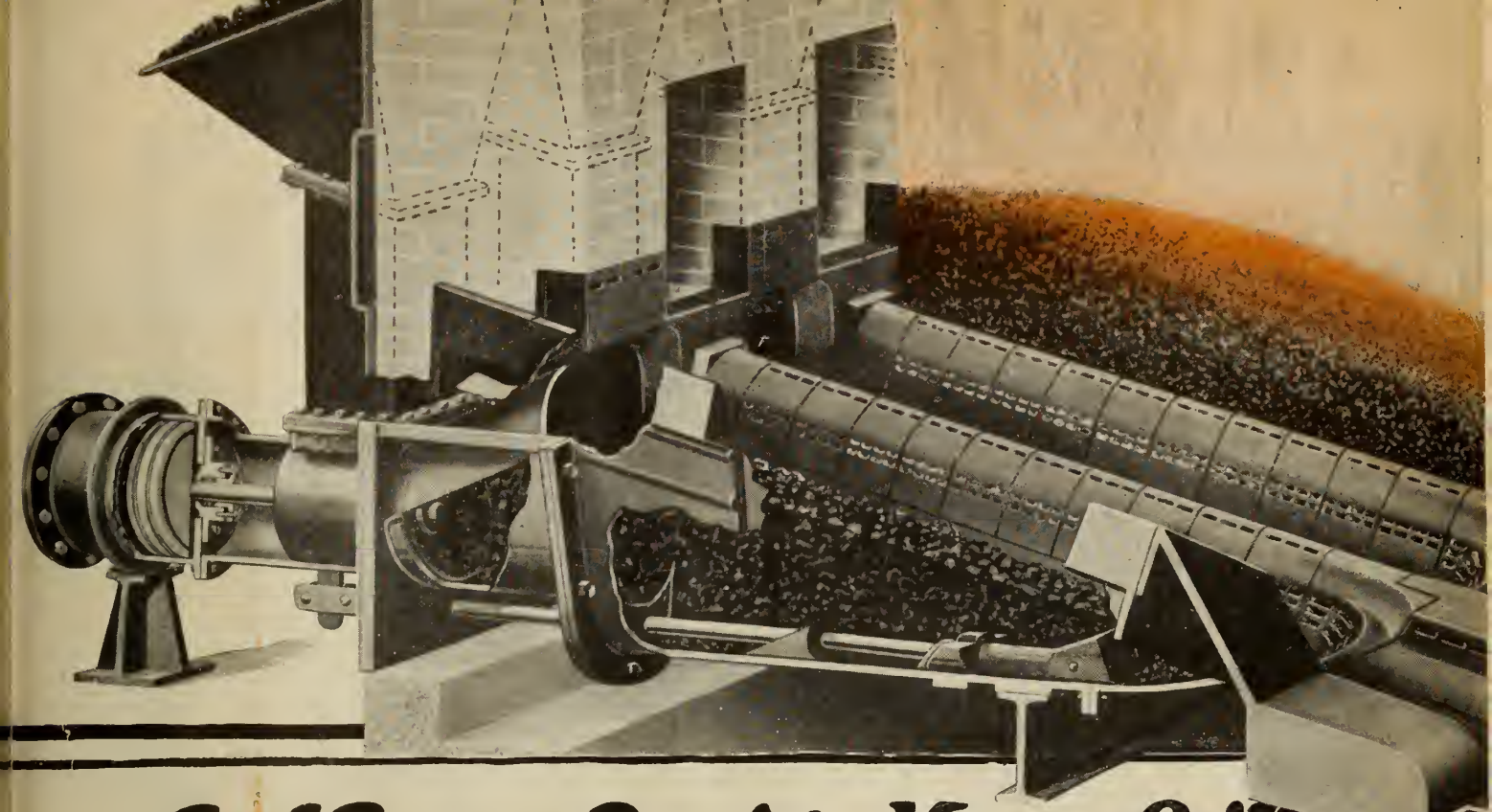

"And Better Design Means Still Better Under-Feed Stoking"

A GLANCE at the sectional view above of the Jones "A-C" in operation reveals its unapproached simplicity *from coal-feed to ash-discharge.* This means low cost stoker service—lower maintenance, less repairs, less operating labor

Note that there is only one moving unit to each retort—the piston, ram and pusher rod. The pusher rod is the only moving part within the furnace and it is buried deep in the green fuel. ***There are no moving parts in the fire.*** Since each retort is a separate, self-contained unit, and, consequently, there is no need for fine alignment, installation expense is minimized. All gears, levers, gear shifts, crank shafts, chain drives, sprockets, shearing pins and clutches are eliminated.

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The reasons for Jones leadership are covered in detail by a newly-printed, highly informative booklet "Ten Points of Jones Superiority." Progressive engineers should request a copy.

Jones stokers are made in three types covering all plant requirements: the "A-C" (Automatic-Cleaning) type for highest duty requirements; the direct cleaned "Standard" stoker, and the "Standard" Side-Dump (self-cleaning) stoker.

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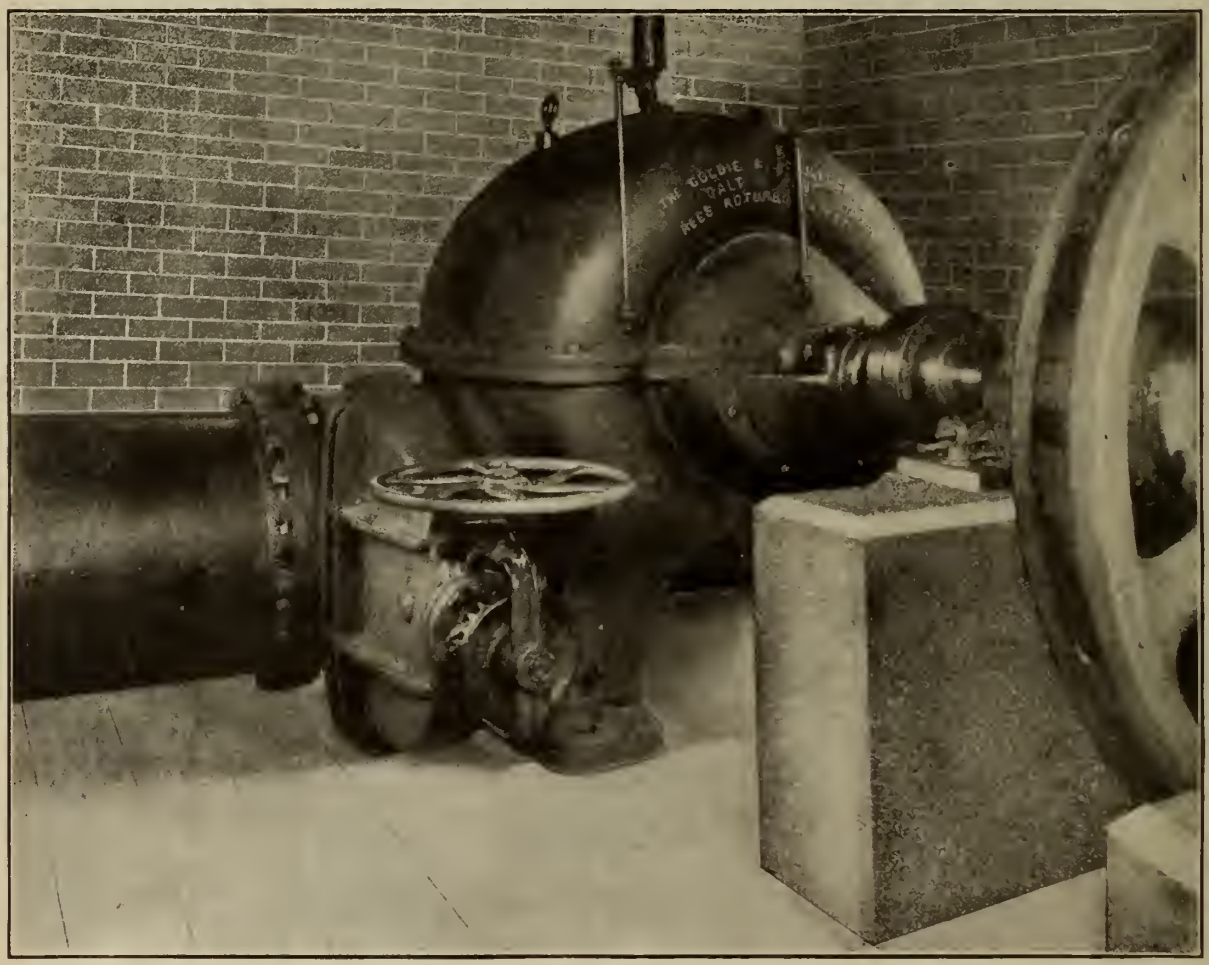
The Canadian Stoker

JONES Stokers are made in Canada by Canadians and sold for Canadian money at par. The old-established Jones Under-Feed Stoker Company, Ltd., has recently been reorganized, and the reorganization makes available for Canadian power users, the extensive engineering resources of the Under-Feed Stoker Co. of America.

"A-C"

DEPENDABLE POWER EQUIPMENT

Rees RoTURBo Pump



Showing a large REES-RoTURBo Pump recently installed by The Goldie & McCulloch Company, Galt, for the Municipality of Kent, Agassiz, B.C., with a capacity of 20,000,000 gallons per 24 hours.

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Published in Toronto

Established 1907
Published Semi-Monthly

How to Make Use of Logarithm Tables

This Is the Third and Last Article on This Subject, and a Number of Calculations Are Worked Out Which Cover Most of the Typical Cases Which Occur in Practice

By T. H. FENNER

A Correction

OWING to typographical errors in the preceding article, it is necessary to make some corrections before going further with the work.

In the first column, first page of the article in the issue of Dec. 5, speaking of characteristics, the ciphers were omitted before the number .415. Thus the text should read: "the characteristic of the log of .415, is $\bar{1}$, that of .0415 is $\bar{2}$, and that of .00415 is $\bar{3}$ and so on." The actual text left out the ciphers, making the three different cases all read .415, which was quite obviously an error.

In the last part of the article, the minus characteristics also got twisted. The revised version is given herewith.

Suppose we have to raise a decimal quantity to a higher power or to find the root of a decimal quantity. Let us take first of all the raising to the 2nd power of a decimal quantity, or getting the square of a decimal quantity, say, .45. Now the log. of .45 is $\bar{1}.633213$ that is the characteristic is a minus quantity. Now how are we to multiply a log. containing a minus characteristic and a positive mantissa? There are several ways of doing this.

Let us take the easiest method first, which is to multiply the mantissa first, and then multiply the characteristic, and then add the two together. Thus we should have .653213 x 2=1.306426, and to this must be added the product of $\bar{1}$ x 2 which is of course $\bar{2}$.

Then we have $\begin{array}{r} 1.306426 \\ \bar{2}. \\ \hline \bar{1}.306426 \end{array}$

The anti-log of this is 2025 and as we have a minus characteristic the square of .45 will be .2025.

A second method is to add a positive number to the negative characteristic, and multiply in the ordinary way. After that is performed, the product of the added positive number and the multiplier is subtracted from the log. already found.

Using our same figures again for illustrative purposes, we have log. of .45 is $\bar{1}.653213$. If we add 10 to the negative characteristic we shall have a positive characteristic 9. That is 10 plus $\bar{1}$ is 9. The log. would then be 9.653213 and this multiplied by 2 is 19.306426.

As we have added 10 we must now compensate for that by subtracting the product of $\overline{10}$ and 2 which is $\overline{20}$ and the log. will be

$$\begin{array}{r} 19.306426 \\ \overline{20}.0000000 \\ \hline \bar{1}.3064260 \end{array}$$

which is we see the same as before.

The Napierian Log

Before giving more examples, we must pause for a moment to notice a system of logs, known as "hyperbolic" or Napier's logs. This system has a base of 2.718282, but is used only in the calculation of abstract mathematical formulae. When it is necessary to make use of this system in the ordinary processes of engineering work, there exists a simple method of converting ordinary logs into Napierian logs, and vice versa. All that is necessary is to multiply the common log by 2.3026, and conversely, the Napierian log can be converted by dividing the common log in the same way. However, it is only in rare cases that this is needed.

The "hyperbolic" or "Napierian" or "natural" logarithm, it being known by all these names, is usually denoted by the symbol e. Thus when we see a formula which contains the expression log e followed by a number, we know that what is required is the Napierian logarithm of the number denoted. Thus in the formula

$$P = P^1 - \frac{1 + \log e\, R}{R}$$

we understand that the product of the common log of R and 2.302 must be added to 1 for the numerator of the fraction. For instance if R=2. Then log e R will be

$$\log 2 \times 2.302$$
$$= .3010300 \times 2.302$$
$$= .6929$$

and log e R=.693

Some Examples of Work

We are now in a position to give examples covering the use of logarithms in a variety of different applications.

Let us take first a formula which is more or less familiar to all stationary engineers, the well known expression for I.H.P. That is

$$\text{H. P.} = \frac{P \times L \times A \times N}{33000}$$

where P=Pressure per square inch

L=Length of stroke in feet

A=Area of piston in sq. inches

N=Number of strokes per minute

Assume numerical values for these, say: P=75, L=2.5, A=16x16x.7854 and N=120 and solve the expression by means of logarithms.

We have

$$\text{H.P.} = \frac{75 \times 2.5 \times 16 \times 16 \times .7854 \times 120}{33000}$$

$$\begin{array}{rl} \log & 75 = 1.8750613 \\ \text{“} & 2.5 = .3979400 \\ \text{“} & 16 = 1.2041200 \\ \text{“} & 16 = 1.2041200 \\ \text{“} & .7854 = \bar{1}.8950909 \\ \text{“} & 120 = 2.0791812 \\ & \hline & 6.6555134 \\ -\log & 33000 = 4.5185139 \\ \hline \log \text{ of H.P.} & = 2.1369995 \end{array}$$

The nearest log in the tables is .1369741 and the anti-log is 13708. As the characteristic is 2 the anti-log or the num-

ber required is 137.08. If we want to get the exact figure we can take the proportional parts by the method already shown, but it is hardly worth while in a calculation of this kind.

The horsepower or the fuel consumption of a vessel varies as the cube of the speed. If the speed is increased to 20 knots from 10, and the consumption at 10 knots is 2 tons per hour, what is the new consumption?

$$10^3 : 20^3 :: 2 : \chi$$

$$\chi = \frac{20^3 \times 2}{10^3}$$

$$\log 20 \times 3 + \log 2 - \log 10 \times 3 = \chi$$

$3 \times \log 20 = 1.3010300 \times 3 = 3.9030900$	
$\log 2 =$	.3010300
	4.2041200
$3 \times \log 10 = 1.000000$	$= 3.000000$
$\log \chi =$	1.2041200

The anti-log of 1.2041200 is 16, and the characteristic being 1 the number is 16, which is the answer.

As an example of raising numbers to different powers, and extracting roots, take the following:

$$\sqrt[4]{\frac{17^3 \times 1.365^2}{1.5^5}}$$

That is 17 cubed $\times$1.365 squared, divided by 1.5 raised to the fifth power, and the fourth root of the quotient extracted. This would be a long process by arithmetic in the ordinary way, and pregnant with possibilities of error. By logs it is simple. It is stated in the following way

$$\frac{\log 17 \times 3 + \log 1.365 \times 2 - \log 1.5 \times 5}{4}$$

Then $\log 17 \times 3 =$	1.2304489 × 3 = 3.0913467
$\log 1.365 \times 2 =$	.1351327 × 2 = .270.2654
$\log 1.5 \times 5 =$	.1760913 × 5 = .8804565

3.6913467)
.2702654) add

3.9616121)
.8804565) subtract

4)3.0811566
.7702891

anti-log of .7702891 is 5.8924

Take the formula

$$(PV)^{1.406} = (P_1V_1)^{1.406}$$

$$P^{1.406} = \left(\frac{P_1V_1^{1.406}}{V}\right)$$

$$P = P_1 \left(\frac{V_1}{V}\right)^{1.406}$$

substituting values

$$P = 50 \left(\frac{1}{2}\right)^{1.406}$$

$$\log P = \log 50 + (\log 3 - \log 2) \times 1.406$$

$$= 1.6989700 + (.4771213 - .3010300) \times 1.406$$

$$= 1.6989700 + .2475843$$

$$= 1.9465543$$

$$P = 88.421$$

Take a case in which we have to divide a whole number by a decimal. That is where we have to subtract a log with a negative characteristic from one with a positive characteristic. For instance the area of a piston is 100 sq. inches and we want its diameter.

$$D = \sqrt{\frac{100}{7854}}$$

and $\frac{\log 100 - \log .7854}{2} = \log D$

2.0000000
$\bar{1}.8950909$

2)2.1049091

1.0524545 = log D

and D = 11.284

When subtracting a negative characteristic we proceed as if performing addition. Thus in the mantissa when we subtract the final figure before the decimal point we have 9 from 0, and we add a unit which must be carried over to the characteristic, and say 9 from 10 leaves 1. Adding this 1 to the $\bar{1}$ in the characteristic we have $\bar{1}+1=0$, and the addition is $2+0=2$

The system is based on the algebraic rule of addition and subtraction. In subtracting algebraic quantities we change the sign and add. Thus suppose we wish to subtract+4 from+6. We change the sign of 4 from+to—and add, thus

$$+6-4=+2$$

If we wish to subtract—4 from+6 we have

$$+6+4=+10$$

To subtract—4 from—6 we have

$$-6+4=-2$$

Now take two logs with negative characteristics, which have to be subtracted. Let us suppose a division sum

.7854
.07854

We have log .7854—log .07854
which is $\bar{1}.8950909 - \bar{2}.8950909$

$\bar{1}.8950909$
$\bar{2}.8950909$
1.0000000

That is changing the sign of the lower quantity we say $+2+\bar{1}=1$, and the answer is 10, because .000000 is the log of 1, and the characteristic being 1, we must have two figures, therefore we add a cipher to the 1, and 10 is the number.

Another example: divide 3.1416 by .7854

log 3.1416 = .4971509
log .7854 = $\bar{1}.8950909$
.6020600

Here again we carry 1 over and adding it to minus 1 we have 0. The log then is .6020600 and the anti-log is 4.

As an example of dividing logs with negative characteristics, take the following. Find the square root of .005.

We have $\frac{\log .005}{2}$

$\text{Log } .005 \quad \bar{3}.6989700$
$\frac{}{2} = \frac{}{2}$

$\bar{3}$ is not divisible by 2. However if we add $\bar{1}$ to it we shall have $\bar{4}$, which is divisible by 2. In order to balance this we must add+1 to the mantissa and we then have

2)$\bar{4}$+1.6989700
$\bar{2}.849485$

and the anti-log is 70710, and as the characteristic is $\bar{2}$, we have .070710. Suppose we multiply this by ordinary methods to see how near we are

.07071
.07071
07071
49497
49497
.0049999041

which is close enough for all practical purposes, the error being .0000001.

In adding —1 to the characteristic and +1 to the mantissa in order to get an equal divisor we have not altered anything, because we have simply said

$$\bar{3} + \bar{1} + 1$$

which gives $\bar{4}+1=\bar{3}$ which is where we started.

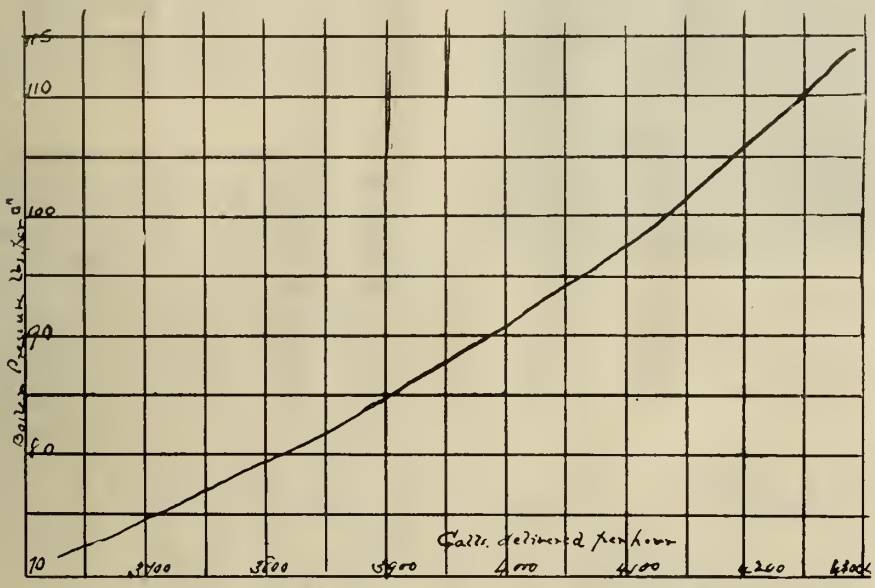
(Continued on page 25)

Results of Tests Made On An Injector

Every Power Plant Engineer, and a Good Many Marine Men Are Interested in Injectors. Here Are Some Facts and Figures Which Clear Up Some of the Dark Points.

By A. WOODBURN

IN view of the large number of injectors which are in use in power plants of medium size, and the interest taken in this type of apparatus by power plant engineers, the following test carried out under the supervision of Professor Angus of Toronto University should prove of value. We are indebted to the James Morrison Brass Manufacturing Co. whose double tube injector was the instrument tested, for the privilege of publishing the particulars of this test.

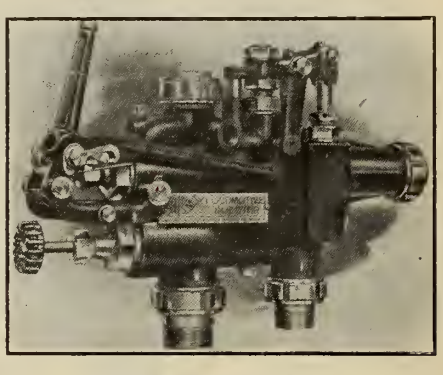


Discharge curve constant suction pressure and varying discharge.

There are a large number of power plant engineers using the injector for feeding their boilers, who no doubt often wonder just what is the condition regarding steam consumption in relation to the amount of water fed to the boiler. The figures obtained in the accompanying test are very illuminating in this respect, and also furnish very good evidence of the efficiency of the injector considered from a thermal standpoint. The injector used was of the type known as the "Morrison" locomotive injector, and is illustrated both in section and by an outside view herewith. In this type of injector the operation is in two stages, one of which consists of lifting the water from the source of supply and delivering it to a chamber from where it is taken and delivered to the boiler by the second stage. The accompanying illustration in section and list of parts shows the construction very plainly.

Experience with locomotive work, has, it is said, demonstrated the fact that the double tube injector is the most satisfactory design for the conditions obtaining in the high pressure locomotive in use today. With this type of injector feed water at a temperature of 100 degrees F. can be handled when the steam pressure does not exceed 150 lbs per sq. inch, and at 90 degrees F. where the steam pressure is from 200 to 250 lbs per sq. inch.

Owing to the liability to erosion due to the high velocity of the steam and water passing through the tubes, a metal of very high resistance is required, and the metal used in the construction of these tubes is of a special quality of hardness, which has been evolved by experiment and research. Great accuracy is also required in the bore of the nozzles, the variation in diameter being within a toleration limit of 1-10,000th inch. The range of working pressures in the type of injector under test, is from 30 lbs per square inch to 300 lbs per square inch. This is made possible by the double tube construction, the regulating valve on the lifter tube being capable of adjustment to any variation.

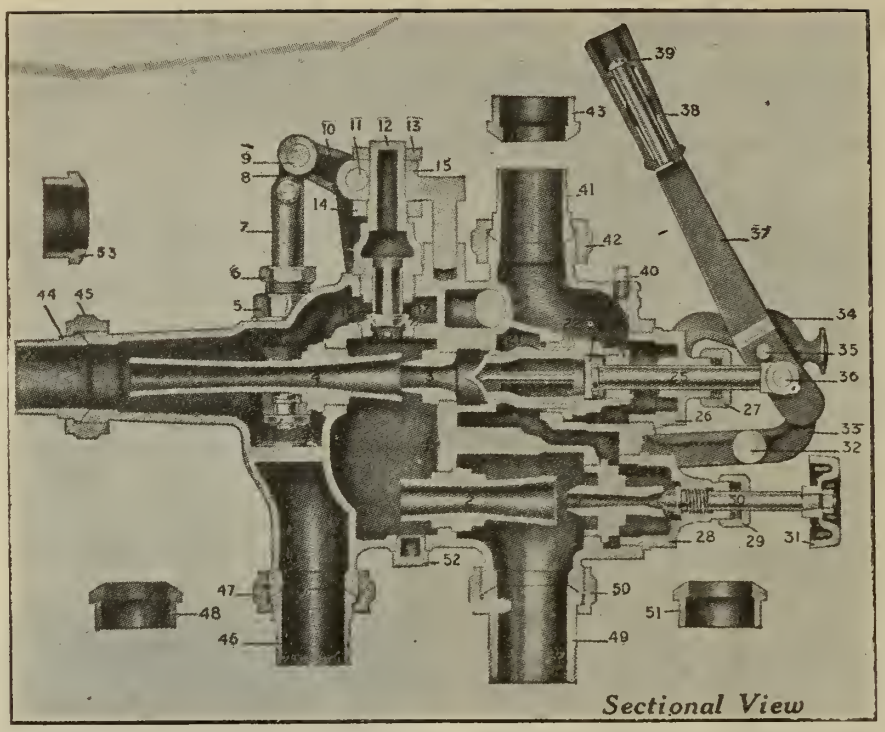


Outside view of injector.

The apparatus used in making the test is illustrated in the sketch. The suction of the

RESULTS OF TEST

1. Length of run (Min.)	15.	15.	15.	15.	15.	15.	15.	15.	15.
2. Barometer (pds. per sq. in.)..	14.5	14.6	14.6	14.6	14.6	14.7	14.7	14.7	14.7
3. Steam pressure (gauge) ...	114.	102.5	92.	82.	71.5	102.5	102.5	102.5	102.5
4. Steam pressure (absolute)..	128.5	117.1	106.6	96.6	86.1	117.2	117.2	117.2	117.2
5. Suction pressure (ins. of h.g.)	6.1	6.5	6.5	6.5	6.5	6.5	8.	10.	12.
6. Discharge pressure (pds. per sq. in.)	120.	105.	95.	85.	75.	120.	120.	120.	120.
7. Water supplied (lbs.)	8039.7	7796.3	7559.0	7172.0	6841.1	7811.8	7733.8	7640.2	7543.9
8. Steam supplied (lbs.)	898.8	861.4	851.3	817.7	717.9	905.1	923.8	961.3	926.9
9. Water delivered (lbs.	8988.5	8657.6	8410.4	7989.7	7559.0	8716.9	8657.6	8601.5	8470.4
10. Lbs. of water per lbs. steam	9.94	10.4	9.27	9.77	10.5	9.63	9.37	8.94	9.14
11. Lbs. of water deliv. per hr. ...	35754.	34631.	33641.	31959.	30236.	34868.	34631.	34406.	33882.
12. Gals of water per hr. U.S.A. .	4290.	4155.	4036.	3836.	3628.	4184.	4155.	4128.	4068.
13. Temp. of discharge water Fah.	140.	148.5	148.	142.	137.	152.25	152.25	153.5	155.
14. Temp. of suction water Fah..	41.	41.	41.	41.	41.	41.	41.	41.	41.
15. Rise in temp. in water	99.	107.5	107.	101.	96	111.25	111.25	112.5	114.
16. BTU's per min. to feed water	53062.0	55873.5	52921.0	48291.5	43783.0	57957.5	56692.0	57301.5	57337.0
17. H.P. rate of work	5.08	4.35	3.84	3.28	2.875	5.01	5.00	5.01	4.97
18. BTU's per min. pump work..	3953.	3382.	2990.	2553.	2135.	3900.	3890.	3900.	3865.
19. BTU'S per min. from steam .	61208.	60814.8	60244.0	57552.9	50396.5	63794.5	67020.0	67737.5	67315.5
20. BTU's per minute returned to boiler	57015.	39255.5	56911.	50844.5	45918.	61857.5	60482.	61201.5	61202.
21. BTU's per min. radiated	4183.	1559.3	3333.	6708.4	4478.5	1937.	6538.	6536.	4113.5
22. Radiation loss per cent.	6.85	2.57	5.5	11.65	10.4	3.4	9.75	9.65	6.3



Sectional Elevation of Injector.

LIST OF PARTS

1 Lifter Steam Nozzle
2 Lifter Tube
3 Forcer Steam Nozzle
4 Forcer Combining Tube
5 Bonnet for Final Overflow Valve
6 Packing Nut for Final Overflow Valve
7 Final Overflow Valve Stem
8 Connecting Links for Final Overflow Valve
9 Steel Bolt for Connecting Links
10 Crank for Overflow Valve
11 Steel Stud for Overflow Valve Crank
12 Bonnet for Intermediate Overflow Valve
13 Lock Nut for Fulcrum Bracket
14 Adjusting Nut for Fulcrum Bracket
15 Centralizing Fulcrum Bracket
16 Intermediate Overflow Valve
17 Intermediate Overflow Valve Seat
18 Lock Nut for Final Overflow Valve
19 Disc for Final Overflow Valve
20 Final Overflow Valve Seat
21 Forcer Steam Valve
22 Forcer Steam Valve Seat
23 Lifter Steam Valve
24 Coupling Nut for Forcer Steam Valve
25 Steam Valve Stem
26 Bonnet for Steam Valve
27 Packing Nut for Steam Valve
28 Bonnet for Regulating Valve
29 Packing Nut for Regulating Valve
30 Regulating Valve Spindle
31 Wheel for Regulating Valve
32 Bolt for Side Straps
33 Side Straps
34 Connecting Rod
35 Steel Stud for Connecting Rod
36 Steel Pin for Lever and Valve Stem
37 Lever
38 Wood Handle for Lever
39 Screw for Wood Handle
40 Oil Plug
41 Threaded Nipple for Steam Connection
42 Coupling Nut for Steam Connection
43 Brazing Nipple for Steam Connection
44 Threaded Nipple for Delivery Connection
45 Coupling Nut for Delivery Connection
46 Threaded Nipple for Overflow Connection
47 Coupling Nut for Overflow Connection
48 Brazing Nipple for Overflow Connection
49 Threaded Nipple for Suction Connection
50 Coupling Nut for Suction Connection
51 Brazing Nipple for Suction Connection
52 Drain Plug
116 Steel Pin for No. 8
147 Spring for Connecting Rod
148 Steel Nuts for No. 36
151 Steel Nuts for No. 32
152 Name Plate
153 Name Plate Stud (old style)
154 Name Plate Screws
155 Spanner Wrench
156 Tube Wrench

injector was arranged to draw from the tank A, and the discharge was led to the tank B. The different connections are plainly marked, and the arrangement can be clearly understood from the sketch. The discharge curves shown are obtained, first with the suction head constant, and the steam pressure varying, and second, with the suction head changing and the steam pressure constant. The third curve shown, shows the ratio of steam used to the lbs of water delivered. In the report of the test the quantities determined are tabulated, the table being given herewith. Following is Professor Angus's report, and the figures obtained.

Description of Test

Test performed on a Morrison Type A.I. Locomotive injector to determine the effects of varying steam pressures and varying suction pressures and to determine the discharge per hr. in gallon per lb of steam used.

Arrangement of Apparatus

The injector was set up to draw water from one accurately calibrated tank marked A and discharge the water into another marked B. Gate valves were placed in both the suction and discharge pipes to regulate the suction and discharge pressures which were measured by a mercury manometer and calibrated pressure gauge, situated between the valves and the injector. Steam was supplied by two Babcock and Willcox boilers giving 150 boiler Horse Power. The steam pressure was controlled by an ordinary globe valve situated near the injector. the pressure being indicated by a tested calibrated steam pressure gauge placed between the control valve and injector. The percentage of moisture in the steam entering the injector was measured by a Peabody's throttling calorimeter connected between the control valve and the injector.

Method of Conducting Tests

The injector was set in operation and when the various valves had been regulated to give the desired pressures instantaneous readings were taken on both suction and discharge tanks. The pressures were maintained at the desired valves for a period of fifteen minutes at the end of which time the injector was instantly stopped and readings again taken on the tanks.

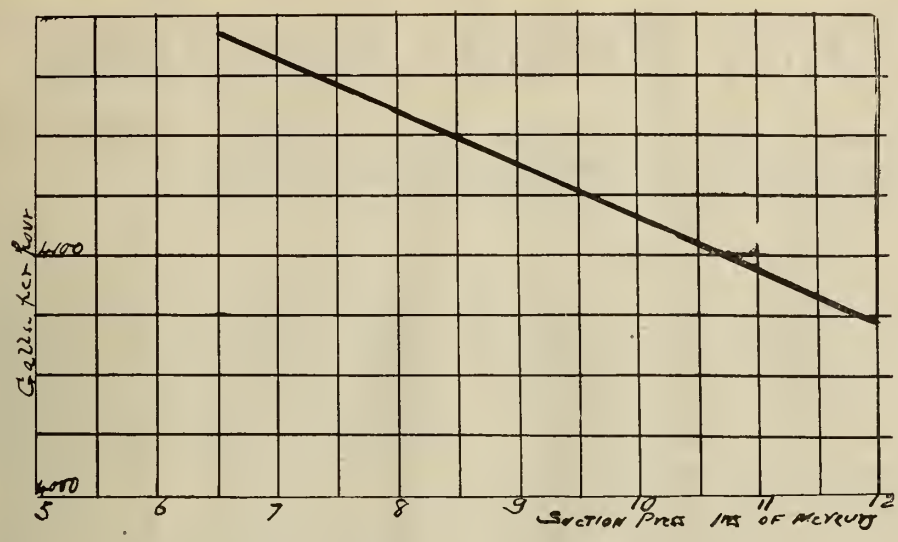
Calculation of Results

From the readings taken on the tanks the weight of water drawn from suction tank and the weight discharged into discharge tank were computed, the difference between the weight discharged and the weight of water drawn from the suction tank giving the weight of steam used.

To determine the discharge per lb. of steam the total weight of water discharged into the discharge tank for a fifteen minute period was divided by the total weight of steam used per fifteen minute period.

The gallons discharged per hr. was computed by multiplying the weight of water discharged in fifteen minutes by four and dividing by ten (the weight of 1 gallon (imperial) of water).

The heat balance was computed by determining the total heat in the steam correct-

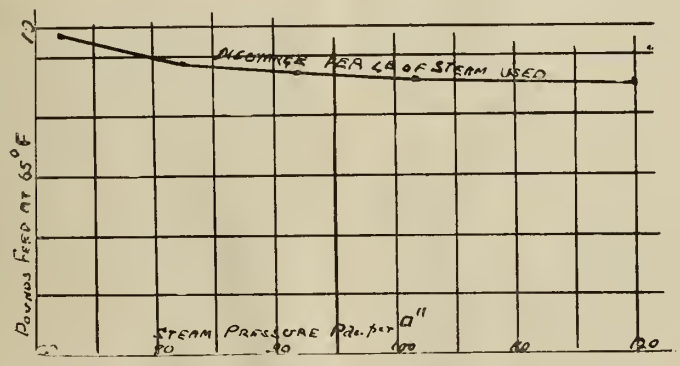


Discharge curve, constant pressure and varying suction pressure.

ing for the quality as found by calorimeter and subtracted from this the heat returned to the boiler in heated feed water, calculated from the weight and rise in temp. of the feed water, and also subtracting the heat energy used in pump work calculated from the pressure differences between the suction and delivery lines times the weight of water discharged. The net result gave the radiation loss.

A discharge curve with varying steam pressure at constant suction pressure and a discharge pressure slightly higher than the steam pressure shows an accelerating decrease in discharge per hour for increasing steam pressures.

A discharge curve with constant steam and discharge pressures and varying suction pressure shows a regular and constant decrease in discharge for a regular increase in suction pressures.



Ratio of steam to water raised.

HOW TO MAKE USE OF LOGARITHM TABLES

(Continued from page 22)

Take one more example. Find the 5th root of .636

We have $\frac{\log .636}{5} = \frac{1.803457}{5}$

5 will not divide into $\bar{1}$ but by adding $\bar{4}$ to $\bar{1}$ we get $\bar{5}$. Then we must add $+4$ to balance it and we have

$$\frac{\bar{5}+4.803457}{5} = \bar{1}.960691$$

and the number is .91346.

Multiplication of negative quantities may be performed in a somewhat similar way—as explained previously. If the multiplier is a single figure, the operation can be performed direct. For instance take the above case, and multiply $\bar{1}.960691$ by 5

$$\begin{array}{r} \bar{1}.960691 \\ \times\ 5 \\ \hline \bar{1}.803455 \end{array}$$

As we have to carry over a positive 4 from the Mantissa, we must add this to the product of the characteristic. Thus we get $\bar{1}\times 5=\bar{5}$ and adding the 4 from the carriage we have $\bar{5}+4=\bar{1}$.

When the multiplier consists of more than one figure, the Mantissa can be multiplied separately, and the product of the multiplier and negative characteristic added after. Take

$\bar{9}.3010300\times 25$

$$\begin{array}{r} 3010300 \\ 25 \\ \hline 15051500 \\ 6020600 \\ \hline 7.5257500 \end{array}$$

add $\bar{9}\times 25=\bar{225}.0000000$

$$\bar{218}.5257500$$

Take the same problem another way. Add $\times 10$ to the minus 9 making the characteristic $+1$. Then multiply

$$\begin{array}{r} 1.3010300 \\ 25 \\ \hline 6.5051500 \\ 26.020600 \\ \hline 32.5257500 \end{array}$$

Then add $-10\times 25=-250$

$$\begin{array}{r} 32.5257500 \\ -250. \\ \hline 218.5257500 \end{array}$$

Take a more reasonable example:

$$\begin{array}{r} \bar{1}.3010300 \\ 12 \\ \hline \bar{9}.6123600 \end{array}$$

By the other method add $+2$

Then

$$\begin{array}{r} 1.3010300 \\ 12 \\ \hline 15.6123600 \end{array}$$

add $-2\times 12=\bar{24}.0000000$

$$\bar{9}.6123600$$

The author hopes these three little articles will serve to dispel the feeling of awe with which a good many men look on this subject, and start them delving for themselves.

In the report of Mr. E. L. Cousins, Department of Industry, submitted to the Board of Control of Toronto this past week, the definite opinion is expressed that normal times are already here. Mr. Cousins stated that the representatives of 17 United States industries have recently investigated manufacturing possibilities in Toronto, and, in the adjustment of the department, there are excellent chances of a number of new branches being opened shortly.

The Canada Paper Co., Windsor Mills, Quebec, have just put into operation a new boiler plant in connection with their St. Francis mill and it contains three 250 h.p. water tube boilers and has room for a fourth.

For Better Boiler Room Operation

This Is the First Section of a Paper Read Before the Stoker Manufacturers' Association—It Shows in a Most Interesting Way the Relation of the Different Items to Cost of Steam

By C. W. DeFOREST

THE boiler room is only one of the links in the chain of operations involved in transforming the energy stored in our coal resources into the electrical energy furnished to consumer. During the recent past, the attention of engineers has been frequently called to the fact that the efficiency of modern boiler room practice is very much higher than the efficiency of producing and mining coal, and of converting the energy of the steam into electrical energy. It might seem, therefore, that attention should be concentrated particularly upon those links in the chain of operations involved in transforming the latent energy of coal into electrical energy available to consumers, where the greatest returns can be obtained from a given expenditure. But while this is true, and is becoming more and more apparent, it can be shown that the possible increase in efficiency in many of our boiler plants, more than justifies the necessary expenditure involved.

In order to follow the title of the subject assigned for this paper, let us first consider the necessity for better boiler room operation. We can do this by briefly reviewing the principal factors which go to make up the cost of producing electrical energy from the coal pile at the generating station to the bus bars.

The three principal factors entering into the cost of production are:

(1)—Investment cost;
(2)—Cost of fuel;
(3)—Organization, personnel, supplies and maintenance costs.

To simplify our problem, we may leave the first factor out of consideration, and assume that the plant and equipment are properly designed and installed.

Let us suppose that we have a modern station, of about 100,000 k.w. capacity, consisting of turbo units of from 20,000 to 35,000 k.w. each, and a boiler plant equipped with boilers each of 1000 rated h.p., or larger, operating at steam pressures of 250 to 300 pounds, and a total steam temperature of from 600 deg. to 700 deg. F. Such a plant, with good load factor, should have a station water rate of 12 pounds per k.w.h. What are the factors which determine the unit cost of energy? The following table, No. 1, shows how the various factors involved enter into the total cost.

Table No. 1

Superintendence, Clerical & Efficiency Dept	2.00
Boiler room operation, inc. ash disposal	5.12
Boiler room repairs	3.80
Engine room operation, inc. electrical	4.60
Engine room repairs	3.07
Miscellaneous expense	4.61
Coal at $4.00 per ton	76.8
Coal at $5.00 per ton	80.5
Coal at $6.00 per ton	83.2

From Table No. 1, we see that the fuel cost at $4.00 per ton is 76.8 per cent of the total; at $5.00 per ton, 80.5 per cent; at $6.00 per ton, 83.2 per cent. These figures are for a plant capacity factor of 41.2 percent. As this factor is increased, the percentage of cost per k.w.h., due to fuel will increase. These figures should bring out clearly the necessity for continued effort to secure better boiler room operation. Where the cost of producing a k.w.h. is higher, the necessity for saving will be more apparent.

Of course, there are three distinct elements which determine the coal per k.w.h. This first transfers the energy of the coal into steam, the second transfers the energy stored in the steam into mechanical energy at the turbine shaft, and the third changes the mechanical energy at the turbine shaft into electrical energy at the generator terminals.

Given turbines and generators of definite characteristics, it is comparatively easy to watch operations and to make the necessary adjustments to maintain satisfactory operating conditions. But the first factor, that of producing the steam, which represents from 76.8 per cent to 83 or 85 per cent of the total cost, is carried out under conditions that are constantly changing. The losses taking place are doing so minute by minute and like "Water through the mill," once lost, cannot be recovered.

The art of fuel burning has made great advances in practice, in the past ten years power station management is recognizing the necessity of equipping the boiler plant with suitable instruments to enable the Combustion Engineer to know what is taking place in the furnace and throughout the heat-transfer equipment. But the mere installation of instruments does not result in the saving of a single pound of fuel.

Let us review the factors entering into the cost of "Boiler Room Operation." Table No 2 shows a typical "Set up" of the gross cost of boiler operation

Table No. 2	Cost per month
Stoker engineers and firemen	$1,980 00
Water tenders	420.00
Heater tenders	378.00
Economizer tenders	624.00
Oiler	120.00
Instrument attendant	240.00
Relief men	284.00
Blowing soot, boring tubes, inspection, cleaning boiler room and apparatus	1,600.00
Proportion of time of assistant to superintendent and chief engineer	150.00
Total cost Boiler Room Operation	$5,796.00

The above table shows that the cost of Stoker Engineers or Firemen, including the time of the Assistant Superintendent, actually given to boiler room operation, is only $2,130.00 per month, or 1.55 per cent of the total cost of power house operation, and including the total cost of Superintendence, Clerical Work and Efficiency Engineer, charging all of the cost to the boiler room, is only 3.25 per cent of the total cost of power house operation.

Five per cent variation in furnace and boiler efficiency represents quite a sum per year; with coal at $5.00 per ton; it amounts to $70,000.00; even two per cent amounts to $28,000.00.

The only way to gain that last two to five per cent in boiler efficiency, is by constant, efficient watchfulness on the part of the stoker engineers, boiler room foreman, and the efficiency engineer, and we cannot afford to employ cheap, inferior men in the boiler room.

In order to get results, we must have the real genuine co-operation of the men. They must be personally interested in their work and the results of their work, and to obtain this end, the conditions under which they work must be pleasant, their wage must be adequate, and they should be kept in touch with the results of their work.

Our Company does not hire experienced firemen. We try to select clean, bright men, with brains, regardless of former experience in the boiler room. In fact, we frequently find, the less experience they have had, the less we will have to overcome. Upon employing a man, he is put in as boiler room helper, then economizer tender, heater tender, boiler maintenance work, and finally on stoker operation or firing.

We conduct two classes a week, at different hours, which it is compulsory to attend. The men are taught the principles of Combustion Engineering and Elementary Mechanical Engineering, as especially applied to the equipment in our station.

The instrument equipment enables us to have a full knowledge of draft conditions and temperatures throughout the furnace, boiler and economizer, steam flow on indicating and integrating meters, pounds and quality of coal used by each boiler and by sampling and analysis, the amount of combustible in the ash. All instruments are carefully maintained and the records carefully compiled daily. After these records are obtained, they are carefully analyzed, and every effort is made to apply the information thus recorded, to maintain our highest standard of performance and, if possible, improve it.

Each day we know the efficiency obtained by each boiler and the general performance of each pass and part of the boiler, from the furnace on up through the economizer. This information is compiled in useful shape daily and checked by the Efficiency Engineer and the Superintendent of Production, and readily shows any furnace, boiler or

economizer that is falling off in efficiency, as well as the reason for this condition.

If we expect to keep a boiler plant up to an average efficiency of from 75 to 80 per cent the boiler plant as a whole must be well maintained. How often we find that equipment will give high economy when new, but that the efficiency drops off after a year's use. It is needless to go over the long list of conditions in a boiler plant that must be looked after. But manufacturers know from long experience, that apparatus will usually meet your guarantees when new and tested by your own engineers, only to fall off when left to the care of the station operators. From this it is apparent that lack of proper maintenance inevitably involves inefficient operation, and that the fault generally lies with the operating force, or the management.

The modern power house, with its multiplicity of auxiliary apparatus, and being worked at increasingly higher stresses, cannot be left to haphazard inspection and maintenance. It is beyond the realm of possibility to expect any engineer or foreman, however conscientious he may be, to remember, in detail, when different apparatus was inspected or repaired. Record filing systems have been devised for performing this function, and it has been demonstrated that they are less liable to error than the most conscientious employee. It is not sufficient that a record be kept of when repair work was performed. A system must be used to insure the regular periodic inspection and maintenance of every piece of equipment.

The scheme we have adopted is to have a card for every boiler, stoker, economizer, motor, pump, all principal valves, switches, cables and every other separate piece of equipment. These cards show the principal data for the equipment as number, capacity, etc., the period of inspection, whether one week, one month or two months.

They are kept in a file, arranged according to date and distributed so that a certain number of cards are handled each day. One man is responsible for the proper handling of the cards and work orders. Each day, the cards covering the apparatus to be inspected or repaired, are taken out and a specific work order issued for each piece of equipment, a perforated stub, bearing the same number as the work order, is retained by the maintenance clerk. The work orders are then given to the Chief Engineer for distribution to the proper foreman and repairmen. After the inspection, or repair, is completed, the work orders are filled out showing the work done, amount of time spent on the work, etc., and returned to the Chief Engineer, who personally inspects the work to see that it has been done according to the order. The completed work orders are then returned to the maintenance clerk, and verified with the stubs. By this arrangement, the Chief Engineer, and his assistants can use their time most effectively—no filing system can perform this function.

This system has enabled us to keep our equipment in good condition.

You will find a great many engineers, who are good men to have when trouble comes and who will work day and night to keep things going, but the man that will save you money, is the one who will forestall trouble, and the surest way is by regular and consistent inspection and repair.

Relation of Stokers to Power House Economy

The real "heart" of the power station lies in the stoker, furnace and boiler. I think they are the one most important factor in the station, certainly from an economic point of view. The stoker handles 80 per cent of the entire cost of power generation, and we cannot give it too much attention.

The three vital considerations in the design and operation of a stoker are :

1. The feeding of coal into the furnace.
2. The air distribution to the fuel bed.
3. The disposal of the ashes.

The general principles of these three operations are determined by the design of the stoker and are settled when the stokers are purchased and installed. Of course, there are innumerable details of design and construction that affect the efficiency and successful operation of the stokers.

Modern stokers are expected to burn coal at high combustion rates, which means that the parts immediately under the fires are subjected to high temperatures and consequent expansion strains. This means that great care must be used in setting up any moving parts that are close to the fire.

The stoker parts are mostly of unfinished castings, but this is no reason why erectors should not use great care in lining up and adjusting the working parts of the stoker; in fact, because the stokers are made of rough castings, are subjected to high temperatures, is all the more reason for taking great care in lining up and assembling the various parts.

Fuel Supply

It is generally conceded that the cost of fuel has permanently reached a higher level, not only due to the cost of mining, but to transportation, and the users of fuel should interest themselves in means and methods to counteract the increasing costs.

There are several ways in which this result can be accomplished, such as:—

More efficient methods of mining and handling of coal at the mines;

Limited storage of coal at the mines, to overcome unequal car supply;

More efficient methods of transportation by "zoning" the use of coal from each district so far as possible.

Creating storage at the consumer's end and taking coal in more regular seasonal quantities, thereby giving the railroads a higher use factor of locomotive and rolling equipment.

This would also allow the mines to work regularly and tend to decrease the miner's wage as, if fewer miners were used regularly, they could afford to accept less hourly wage.

The cost to the consumer of high ash content in coal is not fully appreciated.

In Cincinnati, under the cost of coal and transportation obtaining there, the difference in value between coal of 5 per cent ash and 20 per cent ash is $1.29 per ton, without allowing for increased cost of capitalization for plant due to decreased capacity with high ash content coal.

We have heard a great deal during the past year about powdered fuel, and the statement from some quarters that the stoker will be replaced by some form of powdered or pulverized fuel burning. There is no question but that powdered fuel has been demonstrated to be practical and that coal of low quality can be burned efficiently by the powdered fuel method.

The engineers who have had the courage to develop powdered fuel burning to its present state of practicability, deserve a great deal of credit. The engineering problems involved have been handled with marked ability and the value of this contribution to modern power plant engineering can hardly be over-estimated. But, thus far, I have been unable to find a single powdered fuel plant obtaining a better average over all economy than that obtained by the better types of stoker installations.

It is true that powdered fuel plants have obtained efficiencies that a stoker plant could not obtain with the grade of coal used, but, thus far, powdered fuel plants have not shown a higher maintained economy than the modern stoker plants when coal of average quality that can be successfully burned on stokers, has been available.

At the Cincinnati plant, we obtain an overall monthly efficiency of from 76 to 80 per cent including banked hours. The average boiler h.p. rating will be over 200 per cent and we regularly operate the boilers on peak load up to 300 and 350 per cent of rating. I do not know of a powdered fuel installation successfully operating at 300 per cent of boiler rating. We hear a great deal about what they expect to do, but it is important to distinguish between prospects and actual experience over extended periods of operation.

It would, therefore, appear that the conditions under which the powdered fuel plant is a competitor of the stoker, are:—

1. Where a supply of low grade coal is available that cannot be efficiently burned on stokers, and that can be delivered at the plant at a cost sufficiently low to justify the investment and maintenance cost of a powdered coal plant; and,

2. If the powdered fuel system is developed to a point where it can show a higher maintained, overall efficiency than the stoker, then high fuel cost would become a factor, but the saving in fuel would have to be sufficient to more than balance the cost of preparation of powdered fuel and increased investment. We should also consider the added complications of equipment and operation with powdered fuel burning, with the consequent liability of trouble.

The investment of the powdered coal plant should include the extra investment in boiler plant necessary, due to the lower capacities obtainable with powdered fuel as compared to a modern stoker installation.

For the purpose of testing the valve, water was, for the first time, turned into the penstock of No. 1 generator at the Chippawa development on Tuesday. Formal opening of the plant is expected to take place on December 28th or 29th. There is some concreting work to be done, removal of wood structure and machinery before actual completion of the work.

Fuel Saving In Relation To Capital

Investigation Shows Economy Resulting From Use of Efficient Equipment—Concrete Illustrations Given in Support of the Theory Under Discussion

By JAMES A BRADY*

SOMETHING definite and reliable in the way of information for the enlightenment and guidance of the prospective investor in efficiency equipment seems to be needed, and the object of this paper it to provide evidence to support the rather general understanding that it pays to economize. The author's original opinion was that there would be no difficulty in obtaining an abundance of first-hand information from engineers and owners who have recently installed efficiency equipment. These men invariably express satisfaction with the outcome of their endeavors, and it was thought that a compilation of such evidence would be the best possible manner of presenting this subject to the public.

In furtherance of this idea, numerous letters were written to consulting engineers, chief engineers of power plants, and owners, stating the desire of the author to secure such data. In all cases, with about three exceptions, the replies were similar, and to the effect that, while they had done this class of work, they had no records or data on which to base any figures, and they were therefore, unable to provide the information requested. This in itself seems to be a fitting subject for serious thought.

Engineers in general are supposed to work along lines of precision and not guesswork, and it seems rather like an unfavorable commentary on the profession, as a whole, to state that less than five per cent. of those corresponded with were able to furnish any data at all. It seems necessary, therefore, to draw upon the experience of the few having such data and let these specific instances form the starting point for what is hoped will develop into a strong body of testimony in favor of efficient methods.

Let me first present a theoretical discussion which forms, in all cases, the nucleus of the whole matter. Consider a unit of 500 h.p. to be operated at 200 per cent. of rating over 10-hr. manufacturing period with coal used for starting and banking, which brings up the total coal equivalent of 12-hr. at double rating. This then requires 12,000 boiler h.p.-hr. per day, which, at 4 lb. per h.p.-hr. amounts to 48,000 lb, or 24 tons of coal. Now, assume that the more efficient equipment will either utilize an equal tonnage of a grade of coal costing one dollar less per ton, or by an increase in efficiency reduce the amount of coal actually used by an amount which is the virtual equivalent of the one-dollar differential. We start, then, with either a direct decrease in coal cost or an efficiency producing a differential or saving of one dollar per ton. Twenty-four tons at one dollar would provide a net saving of $24 per day.

Now, the investment necessary to save this amount, we will say, is made up as follows:

One mechanical stoker	$5000
Fans and installation cost in excess of equivalent hand-fired setting	2000
Total	$7000

This amount of $7000 divided by 24, gives 292 days as the time required for completely recovering the initial investment. This is approximately the number of working days in one year, so that in this case, it could be stated that the investment provided a return of 100 per cent. per annum. Should there be a greater or less differential in the price of coal or in the efficiency, this figure must be modified accordingly, or if there is a greater cost initially, the returns would be correspondingly diminished; but assuming that this is substantially correct, the dividends are of such magnitude as to overshadow any other form of investment other than finding the money or striking oil. It can be reduced to one-half or one-third of this figure, and still loom up as a phenomenal return for any concern, however prosperous. It is more than improbable that any such return can be secured by investing the same amount of money in equipment directly providing the output of the institution in queston.

To support this by specific evidence, the author presents a few concrete illustrations. The power plant of the Waterloo, Cedar Falls and Northern Railway Company was overhauled in the fall of 1913, and the author followed this installation through for some two years thereafter.

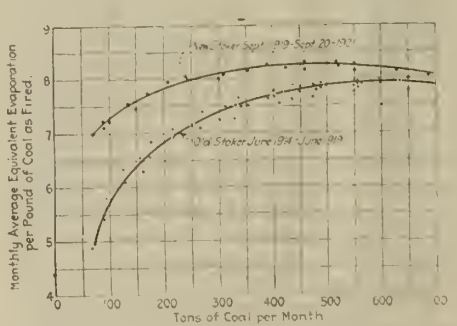


Fig. 1.

Two of the resulting curves are shown in Fig. 1. In this case there were four 500-hp. boilers installed, replacing older water-tube boilers which were also fired with the same make of stoker. With the same stoker, the same fuel, and similar boilers the savings may very definitely be attributed to the greater efficiency secured by the then more modern setting. Not only was the furnace better proportioned and much more ample, but efficiency equipment was installed, such as gas-analysis recorders, draft gages, recording thermometers, feedwater heaters, and coal-weighing equipment. A simple system was developed for watching the indication of these instruments and drawing therefrom the logical deductions. In this particular instance, the new equipment actually paid for itself in a little over a year's time. It will be observed that the coal cost per kw-hr. was just about cut in two.

During the summer of 1919 the Armour Institute of Technology made a change in their mechanical stokers from the old-style chain grate to the new traveling grate, boiler and other conditions remaining exactly the same. The modern stoker had a better grate ratio (70 sq. ft. grate surface as against 90 sq. ft.) and was designed to be more efficient at the lower ratings which occurred during the major portion of the year. Only for about two months in the year was the boiler worked up to anywhere near its capacity. Natural draft was used throughout this period—chimney 175 ft. high. The average pressure was 100 lb. gage and the average feedwater 198 deg. Fahr. The remarkable result of this change is best shown in the curves in Fig. 2, furnished by Professor Gebhardt, and in the accompanying data in Table 1. Owing to the fact that no change was made in this case other than the stokers, we can safely attribute the improvement to the improvement in the stoker. Figuring on the basis of Cartiervi.le, Ill., No. 3 washed nut coal at $5.67 per ton delivered to the boiler room floor, an annual gross saving of $1553.58 was realized on the total saving of 274 tons of coal. The average cost of repairs to date is $50. The approximate price of the new stoker was $3500 and the installation cost $1000, making a total of $4500. The return on the investment is therefore 33 and one third per cent.

By a change in the brickwork surrounding the boiler, both of these improvements were accomplished. Examining the boilers it was found that

*Vice-President James A. Brady Foundry Co., Mem. Am. S. E., presented at the annual meeting A.S.M.E.

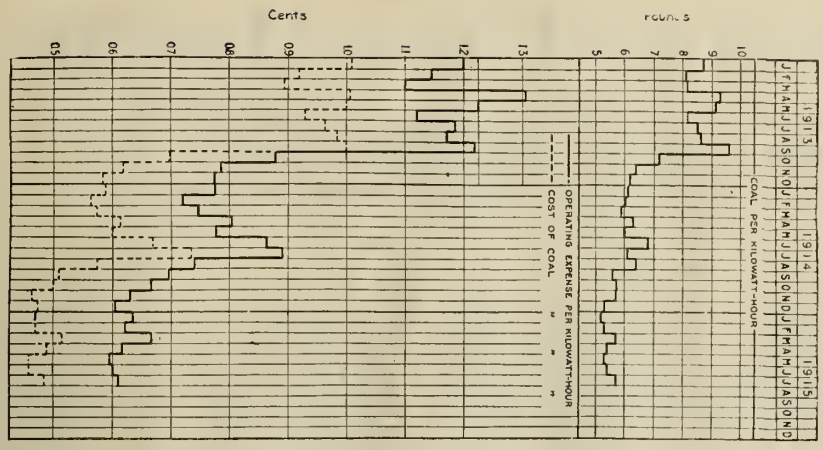


Figure 2

there was insufficient circulating space between the tubes; this was corrected by removing one of the center rows and several tubes at the sides, which too closely approached the shell. These changes provided circulating space for the downward and upward flow of the water.

A third instance of a quite different nature is exemplified by the work of Neiler, Rich & Co. at the University of Chicago during the past season. The boiler room here consists of a number of 72-in. by 18-ft. horizontal return tubular boilers, stoker-fired, and using the usual run of bituminous coal that comes into the Chicago market. Considerable difficulty was experienced in carrying the 1919-1920 load on twenty boilers. Neiler, Rich & Co. undertook to keep this plant in operating condition until a new plant could be completed, so that what was done was merely for the purpose of keeping things going until that time, and not with the idea of a permanent improvement. No attempt was made to change any of the equipment, but it was found that the draft loss due to circuitous gas passages was very great, providing insufficient furnace draft. The combustion chamber was entirely too small, so that attention was given to improving these conditions.

Apart from patching up the brickwork, covering pipe lines, etc., nothing else was done; but it was found that these changes enabled the engineer to carry a somewhat increased load on fourteen boilers. The same coal was used, and the same chimney and breeching connections were retained, so that in this instance the economies are properly credited to improved boiler circulation, furnace draft, and combustion space. The coal saving is not proportional to the number of boilers used, because the better circulation in the boiler enabled higher capacities to be carried. Very accurate figures are not available in this instance, but it is beyond controversy that the cost of the improvements made will be covered by the fuel saving, within the period of two heating seasons.

CAMERA TO HELP SAVE COAL

Savings in coal consumption may be effected through the instrumentality of the motion picture camera, it was said at a meeting of the American Society of Mechanical Engineers. The camera has been used to record the phenomena of combustion in big furnaces at a range so close that the eye could not withstand the heat long enough to make the necessary observations. Motion pictures of coal combustion taken under the highest temperatures were exhibited by R. Sanford Riley, manufacturing associate of the inventor of a special camera designed to make pictures in a blast furnaces, glass furnaces, gas and other similar plants.

Professor A. G. Christie of Johns Hopkins University condemned "quantity production," in American colleges, and C. F. Pratt of Schenectady, representing the General Electric Company, said that a survey of the plants of his company would show that "our educational institutions are developing young men of real ability for the industry." Professor Christie quoted Dan F. L. Bishop of the University of Pittsburgh as having said that there was no first-class engineering school in America. He said that this view was supported by Professor Comfort A. Adams of Harvard, formerly Chairman of the National Research Council. Professor Christie urged the adoption of a national policy on engineering societies. He said that the Engineering Department of Johns Hopkins was endeavoring to raise standards by limiting attendance among the upper classmen to a small number.

TREATING ASHES TO SAVE UNBURNED FUEL

Washing tests made in the laboratory of the mining department of the University of Illinois show the possibility of recovering the unburned fuel by crushing the refuse to 3-8 in. ring size, washing on coal-washing tables, and removing the slime from the washed product by a dewatering conveyor elevator or a screen. The coal-washing table is a standard-piece of coal-washery equipment, similar to the concentrating table commonly used in ore-dressing plants.

Two washing tests were made, one being with 3-8 in. mesh screenings from the general sample, and the other with the over-size crushed to pass a 1-4 in. round-hole screen. Combining the results of these two tests gives the average results for the entire sample of refuse as received from the powerhouse. The total combined yield of washed fuel was 20 per cent of the gross weight of refuse treated. The washed fuels had an ash content of 25.5 per cent and an average calorific value of 9754B. Th. U. The heating value of the dry screenings ordinarily fired at the plant is about 10,000 to 11,000B. Th. U., and the ash content 18 to 22 per cent. At a great many plants the boiler-furnace refuse contains a larger percentage of recoverable fuel. Operation of a table washery on refuse such as is produced at this plant would result in the production of one ton of fuel from each five tons of refuse handled.

The equipment required for a simple plant of this size consists of a corrugated roll crusher to which the refuse is fed by a chute direct from the power plant. The crusher should be set to crush the refuse to about 3-8 in. maximum size. The crushed material is stored temporarily in a feeder hopper of about five-tons capacity, from which it is fed to a washing table by a short screw conveyer. Two inclined dewatering drag conveyers elevate the recovered washed fuel and also the discard from collecting sumps to their respective storage bins, and at the same time remove the water and fine slime.

Operation of such a plant would require only a part of the time of one man, as a coal-washing table needs only occasional attention after it is started and properly adjusted. In most cases the freight charges on coal purchased to replace this recoverable unburned fuel would be more than sufficient to cover the cost of operation.

BULLETIN

The Underfeed Stoker Co. of America have issued a bulletin describing the new side dump underfeed stoker. Instead of the hand cleaned side plates as fitted in the ordinary hand cleaned stoker, dumping side plates are fitted, which are operated by levers from the stokehold floor. The new stoker has been designed to meet the need of a cheap installation of a self-cleaning stoker. In all other respects it is similar to the usual underfeed handcleaning stoker The bulletin is fully illustrated and the apparatus is well described.

ANNOUNCEMENTS

The Superheater Company Montreal, announce that they now have an associate connection in Paris. This office will operate under the name of Le Compagnie des Surschauffeurs, and this company has been given full, rights for the sale and manufacture of "Elesco" return bends, superheaters, and other "Elesco" products. The company is located at 11 Rue Scribe, Paris France, with a factory on the outskirts of Paris.

The Simplex Iron and Tool Co., has been incorporated to manufacture adjustable wrenches. They are located at 216 Adelaide St., W., Toronto, and Mr. Dunlop, president of the Dunlop Coal Co., is also president of the above mentioned concern. Mr. Harington of the Harbor Commission, is vice-president of the new firm.

The Lubrication of Prime Movers

The Question of Lubrication in These Days of High Speeds and High Temperatures Is Somewhat More Difficult Than Formerly—Some of the Factors Leading to Success Are Given in the Following Article

By C H. BROMLEY

OF ALL prime movers the steam turbine presents the severest condition for the lubricant. The journal speeds are higher than in any other class of machinery; the bearing pressures are relatively low, yet they are great, and becoming greater; the temperature, particularly of the bearing adjacent the high-pressure end, also the thrust bearing, is extremely high, even normally. Total steam temperatures at the throttle of between 600 degrees and 700 degrees F. are becoming common. Heat at this temperature is conducted to these bearings in addition to the heat of friction generated in the bearing itself. The oil circulates to the bearings rapidly—from 7 to 40 times per hour.

With these conditions to be met, the lubricating system must function so that at no time, not for a fraction of a second, shall there be metallic contact or metallic friction between the journal and the bearing shell. I know of no case where metallic friction has occurred that severe damage to the turbine did not result. The oil-pressure varies from 2 to 15 lb.; usual oil temperatures are between 130 degrees F. and 180 degrees F. Thrust-bearing temperature is usually—2° degrees F. higher than that of other bearings, except the high-pressure end bearing.

Oils for Steam Turbines

Our experience, as well as that of others, shows that for steam turbines nothing but a straight-run mineral oil will do. It must not be compounded or blended with any product, not derived from crude petroleum. There should be no animal or vegetable fats in it. Water will get into the lubricating oil in a steam turbine, however careful the design and machinery of the unit, and however cautious the operator. And oil containing animal fats will emulsify and form sludge so badly as to be dangerous. The Prime Movers Committee of the N.E.L.A. in its 1921 report, page 6, well states it as follows: "Compounded oils are not to be considered, as turbine oils should be strictly pure, neutral mineral oils, without any admixture of animal or vegetable fats." The flash-point, open cup, should not be lower than 315 degrees F. for extra-light oil, to 335 degrees F. for medium. High flash-point is desirable, as it indicates slow evaporation and ability to retain original viscosity, provided also that the oil is slow to oxidise.

There is still much to learn about viscosity for turbine oils. However, the safe guide limits now are 110 secs. to 350 secs. Saybolt at 100 degrees F. The higher the speed the lower the viscosity may be. I have heard of excellent results with oil of 80 secs. viscosity. While this may be "sliding on pretty thin oil," to paraphrase an old expression, it is probable that we will eventually discover that there is no need for as much apprehension about thin oil for turbines as is now general. What chiefly concerns us is the viscosity at normal operating temperatures, and the ability of the oil to retain its viscosity throughout a long period of service.

Emulsion and Sludge

Emulsion and sludge form one of the chief worries of the turbine operator. If allowed to accumulate, they make impossible safe operation of the turbine.

An emulsion is a mixture of liquids, insoluble in one another, where one is suspended in the form of minute globules; also it is a mixture in which air and solid particles, or both, are suspended in a liquid. The turbine oiling system is practically ideal for promoting the formation of emulsion. Water and moisture will get into the oil from leaky shaft glands, leaky oil-cooler coils, and bearing cooling coils where water-cooled, also from the atmosphere. The churning to which the oil and water are subjected in the circulating system forms an emulsion wherein the particles are very finely divided. Obviously the pressure oil film in the bearings will be seriously impaired by such an emulsion, and the risk of serious damage to the turbine will be imminent.

Sludge is that nasty, brown-blackish substance one finds in the turbine-oil reservoir, oil cooler and oil piping. It is the result of oxidation of the oil. If emulsion is allowed to accumulate, it soon results in sludge. The unsaturated compounds in the oil are more rapidly oxidised, and the metallic particles, dirt, dust, etc., apparently act as catalytic agents, for the formation of sludge increases at an accelerating rate with the formation of organic acids.

Standard of Demulsibility

It is up to turbine operators to demand the adoption by engineering societies of some workable standard of demulsibility for turbine lubricating oils. The term "good" demulsibility means nothing to an engineer, yet that is about all the information generally available.

Here is a way to make the Bureau of Standards test for demulsibility that is practicable: Apparatus necessary—a malted-milk mixer such as used at soda fountains, a thermometer, a 100 c.c. graduated vial, and an electric hot-point or other means of heating the sample. Mix 40 c.c. of water at 55 degrees C. (132 degrees F.) with 20 c.c. of oil. Keep the mixture at 55 degrees C. and emulsify in the mixer for five minutes. The number of cubic centimetres of water that settles out in one minute multiplied by 60 (the number of minutes in one hour) equals the standard demulsibility number for the oil. The perfect number is 1200, being 20, the total water volume, multiplied by 60, the total number of minutes in one hour.

Where the oil is continuously kept clean, as in the continuous bypass system, the acid content seldom, if ever, gets over 1 per cent, even after years of service of the oil. In fact, analyses have shown less acidity after two years' continuous use of oil purified by the continuous bypass system than the oil contained originally. The explanation probably is that the acid is entrapped in impurities in the oil, and the continuous removal of these keeps down the acid content.

Methods of Maintaining the Quality of Turbine Oil in Service

We may disregard sweetening and merely add make-up oil, because in modern practice, particularly with turbines of from 700 kw. capacity upward, no one would think of trying to keep the oil in good condition by such means. To attempt to do so is to fail, because one merely dilutes the impurities; they are not removed.

Batch filtration was universally practised until a few years ago, or until the advent of the continuous bypass system. Batch filtration was a decided improvement over sweetening, but it has several objectionable features. The entire oil charge is drained at intervals—when, rests entirely upon the operator's judgment and upon circumstances which may delay the cleansing of the oil until long after it should have been done. The quantity of oil in reserve must be large. The really serious objection is that batch filtration does not prevent the accumulation of emulsion and sludge.

When considering turbine-oil purification, the average engineer thinks of oil loaded with emulsion, filth and sludge. He must see it differently, for with modern means available the oils never get unfit, provided the right oil has been selected, the oil reservoir and piping are clean to start with, and water and steam leakage from shaft glands, cooler, and other sources are kept down, as they can and should be.

This system of purification, adopted as standard by one large builder of turbines and highly endorsed by all other turbine builders and leading oil companies, consists of a sight over-flow, a filter, an oil pump, and the necessary piping. The vented sight overflow is connected directly to the turbine-oil reservoir, so that its overflow level corresponds with the desired oil level in the reservoir. The outflow of oil from the reservoir is automatically controlled by and is equivalent to the amount of oil delivered by the filter pump from the filter to the reservoir. Should this pump stop for any reason, the turbine continues to operate as though no system were installed, as this system is entirely independent of the self-contained oiling system of the turbine furnished by its builder. It is plain that a

*A paper read before the System Operators' Association.

certain percentage of the total oil charge is passed through the filter per hour, and that purification of the whole charge is continuous. Emulsion and sludge cannot accumulate, as they are removed as fast as formed. At first one is likely to say that with this system clean oil from the filter is put into the dirty oil in the reservoir. The answer is that with this system there is no dirty oil either in the turbine reservoir or the filter.

Diesel-Engine Lubrication

Diesel-engine cylinders cannot be successfully lubricated by methods satisfactory for steam or air engines. Unless application of the lubricating oil is timed for a particular part of a particular stroke, there is every likelihood that, without extravagant use of oil, the lubrication will be burned away before it has time to function as a lubricant.

In the practice of one of the leading Diesel-engine builders the oil is delivered to the piston through the cylinder wall at two places 180 degrees apart. For the piston pins the oil is fed through the cylinder wall into a slot in the piston which comes even with the oil hole when the piston is on its lower centre.

The lubricator uses alternate forcing plungers on opposite sides of the gear or plunger-actuating shaft; thus any two adjacent plungers force oil when 180 degrees apart. By arranging the feeds in groups, each group on a separate gear-shaft, and the shafts driven through gears or eccentrics or chains from the engine, any desired timing of delivery may be had. Ordinarily, the lubricator has a layshaft and three eccentrics set 120 degrees apart; the lubricator gear-shaft is so divided that eighteen feeds are driven in sets of six to each eccentric and of these six feeds three plungers are on one side of the gear-shaft and three on the other. The lubricator has a divided oil tank to permit of using a different oil for the air compressor of the engine.

The oil is delivered among the piston rings on the lower centre at the end of the power stroke. This ensures thorough coating of the cylinder wall before the power strike, during which the cylinder temperature is greatly increased owing to combustion.

Usually the crankpins and main bearings are lubricated by a gravity system which supplies the oil through gang sight-feed oilers, located on the engine frame columns.

A leading builder uses two feeds for each main bearing, and one feed for the centrifugal oiler for each crankpin. All oil fed to these bearings and to the piston pins is caught in the engine base. One end of a small double pump delivers the oil to a filter conveniently located, the other end taking it from the clean-oil compartment of the filter and delivering it to a tank at such elevation as to give the desired pressure at the sight-feed gang oilers feeding the bearings.

Camshaft rollers are grease lubricated by hand-operated cups and valve tappets and rockers by oil from a squirt can. These could be automatically lubricated like the rest of the unit, but is purposely not done so, to ensure attention and watchfulness on the part of the operator.

In marine practice practically the entire engine is force-feed lubricated at low pressure. A tank in the ship's double bottom holds the oil supply. A circulating pump discharges into a cooler and then into a main parallel with the engine bed; branches from the main supply each main bearing and the thrust bearing. Holes in the crankshaft register with circumferential grooves in the main-bearing shells and feed oil to crankpins and piston pins.

Practice in Marine Diesel Engines

The usual precautions are, of course, necessary to prevent leakage of salt water into the oil reservoir or sump, and into the oil supply from the cooler. Here pistons are oil-cooled and the crankpins and piston pins are supplied with oil through holes in the crankshaft and connecting rods, trouble is likely to arise owing to carbonised oil flaking off and clogging the oil passages.

These engines are, of course, tightly enclosed and bearings cannot be felt for temperature. A thermometer in the oil-return pipe will indicate a serious temperature rise, but will not indicate the bearing affected. Various jimcracks to indicate such have not been very successful. Care is therefore necessary to adjusting bearing clearances and keeping the oil, oil tank, and passages clean.

Reclamation of Internal-combustion Engine Lubricating Oil

Naturally, because of the high temperature, considerable carbon is formed. When the oil is too heavily loaded with it, the carbon must be removed. This carbon is extremely fine. Filtration alone or centrifugal separator alone does not remove it all satisfactorily. The best results are obtained by the use of the reclaimer.

This reclaimer is in the form of a cylindrical shell. The dirty oil is heated by steam at 212 degrees or higher to bring about a satisfactory difference in the specific gravity of oil and foreign articles and water. After the heating period a coagulant is mixed with the oil and the mixture allowed to settle. Usually a batch of oil is reclaimed every twenty hours. After settling is completed it is best to allow the oil to run through a filter, which is readily attached to the reclaimer. These reclaimers are built with electric-heating elements where steam is not conveniently available.

ECONOMY IN THE BOILER-HOUSE

Below we reproduce a diagram for the guidance of boiler-house staffs, issued by the Fuel Economy Committee of the Federation of British Industries, 39 St. James's-street, London, S.W.I. The diagram can be obtained printed on metal plates 20 in. by 30 in. for hanging in the boiler-house.

1. Avoid wastage of cinders in the ashes by cleaning the fires carefully and by using suitable firebars.
2. Avoid production of black smoke and incompletely burnt gases by regularly and frequently firing coal in small quantities. Keep a proper depth of fire.
3. Regulate the draught by the damper to reduce the excess air. Try to obtain 12 per cent CO_2 in the chimney gases.
4. Keep the grate properly covered with a level fire. Use the rake when necessary for this purpose.
5. Examine the boiler setting carefully for air leakage, particularly furnace doors, cracks in the side walls, joints between the boiler shell and brickwork, and the damper slides.
6. Keep the boiler surfaces free from soot and flue dust.
7. Keep the internal boiler surfaces free from scale.
8. Do not force the boilers unnecessarily.
9. Examine the seating blocks and partition walls carefully. Repair if necessary to avoid by-passing.
10. Lag the exposed surfaces of boilers and steampipes efficiently.
11. Avoid excessive blow-down.
12. Keep the boiler filled to the working level by a continuous and steady feed.
13. Avoid leakages of steam from boiler fittings and valves.

Word has been received from Montreal that the International Paper Co., is planning to start its newsprint mill at Three Rivers, Quebec, during the month of February. It is understood that the initial production will be 100 tons a day from two machines with a capacity of 50 tons each. It is planned to increase this amount shortly, if the market warrants, by another 100 tons a day, making the total production 200 tons a day, or 60,000 tons per year.

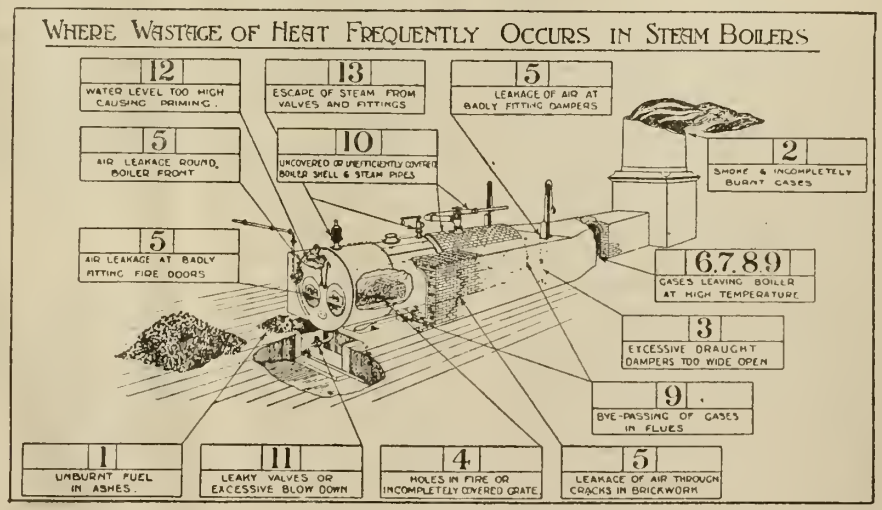


Diagram showing boiler losses.

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POWER HOUSE

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The Season's Greetings

TIME IN ITS steady course has once more brought round the season when it is a pleasant privilege to wish our readers the greetings of the Christian peoples. It is with sincerity and heartiness that we take the opportunity of wishing you, collectively and individually, a "happy Christmas and a prosperous New Year."

It is unfortunate, but inevitable, that a good many engineers are unable to spend the whole of Christmas Day with their families, but somebody has to be in charge, holiday or high day, where steam has to be kept handy. This is a necessity unavoidable. However, it can usually be arranged so that each man can spend a part of the day at home, and the dinner hour can be made to suit him for that one occasion.

Again, there are those who prefer New Year's Day to Christmas Day for their celebration, notably those whose ancestors or themselves come from the north of the Tweed. There are pleasant customs associated with New Year in some parts of the country which give it a charm of its own. For instance, in Quebec, one is privileged to kiss the matron or maid who opens the door when making a call on New Year's Day, and many can testify with pleasure to the excellence of this idea. In fact they would like to see it more generally adopted, and with the gradual spread of brotherly and sisterly feeling, who knows?

This is a time of prospect and retrospect. Probably the most important feature of the past year or two from the stationary engineer's standpoint has been the working out of the graded certificate law, and in our opinion, taken as a whole, it has worked for good. There are many phases of its operation which have perhaps made for injustice, but considering how radical a departure from previous practice it was, this was perhaps only to be expected. We believe that it has accomplished one of the principal reasons of its creation, that is the raising of the standard of education from an engineering viewpoint, of those who come under its jurisdiction.

While it is difficult to judge from the individual, it is easy to see the trend of events as reflected in the attitude of those societies formed of and devoted to the interests of the stationary engineer. In the case of the Canadian Association of Stationary Engineers, a very definite and wide-spread movement for better education has been developed. Every encouragement is being given to the members of the various lodges, not only to improve their own standard, but to raise that of every member by mutual help. Competition has been stimulated, and assistance of a material nature has been afforded by firms engaged in the manufacture and sale of the appliances operated by the stationary engineer. Another strong and representative body of engineers,—the Universal Craftsmen's Council of Engineers, have also adopted a policy of education with their other activities.

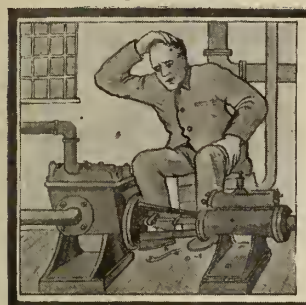
The action of these two societies must be reflected among engineers in general, because it is a fact, that as a man becomes imbued with greater knowledge of his profession, he becomes broader-minded, and more willing to share his knowledge with others less fortunate. The old retarding spirit which urged a man to guard his painfully acquired knowledge as a possession that belonged to him alone is fast disappearing. It was a wrong spirit, and tended to a narrow-minded and self-centred viewpoint which worked against the best interests of the possessor himself and those with whom he came in contact. Stationary engineering practice is to-day such a diversified thing that no one man can expect to know it in all its ramifications. It is only by sharing his knowledge of his particular branch, and getting in exchange the experience of others familiar with different practice, that he can round out his grasp of the essentials.

We hope that every engineer will start the New Year with the firm intention of adding to his own knowledge, and at every opportunity, to that of others. By consistently following out this policy, he will be building up a standard of efficiency among engineers in general which will re-act to the good of the whole profession, and make the passing of examinations a simple and pleasing task. Have no fear that it will result in making every man as good an engineer as the next, for in the course of human events, there will always be, in every line of endeavor, men who stand out from the others. Starting with the same education and advantages, there are inevitably men whose native abilities enable them to make a better use of the materials at their hand, and whose keener insight will grasp an opportunity unseen by their fellows.

From a personal standpoint we feel that we have come closer in the past year to our readers and contributors than we were a year ago, and by their help have been able to give them a stronger and better paper than ever before. It will be our endeavor to so continue in the year to come that "Power House" will retain the respect and loyalty of its readers. It is our aim to serve their interests in such a way as to receive continued co-operation.

A Scientific Institute

ACCORDING to information received, Baron Edmund De Rothschilds, administrator of the Eastern Railway of France, has given ten million francs to found a scientific institute, the object of which is to encourage students to take up research as a career. Particular attention is to be given to researches looking to the application of science to industry and agriculture. The institution is to be managed by a council, two members of which are elected by the Academy of Science and the French Museum.



OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

WORK DONE BY AMMONIA MACHINE

Question:—In a direct expansion system of refrigeration how would you calculate the amount of work that the machine was actually doing?

Answer:—The actual work done by an ammonia refrigerating compressor depends upon the volume of gas pumped per hour, and its cooling effect. These quantities vary with the condensor and evaporator pressures but a typical case can be illustrated which will show the general principles governing the calculations.

Take a compressor of 7½ inches diameter by 10 inches stroke, running at 75 strokes per minute, with an absolute condensor pressure of 125 lbs. and an absolute evaporator pressure of 41 lbs. From tables compiled by various authorities on the properties of ammonia we can ascertain the volume of gas handled, and its cooling effect per lb. at the temperatures and pressures named.

Ammonia gas at a pressure of 41 lbs. absolute has a temperature of 12.2 F. above zero, and a volume of 6.99 cubic feet per lb. Its latent heat is 562.6 B. T. U. Assuming that the temperature of the liquid in front of the regulating valve is 68 degrees F., then before the liquid evaporates after passing the expansion valve, it will give up the difference between the 68 degrees and the evaporator temperature, or if a direct expansion system the difference between 68 degrees and the surrounding air. The temperature corresponding to 41 lbs. being 12.2. we can assume that the surrounding air is at 10 degrees higher say 23 degrees. That means that 45 B. T. U. approximately will be given up to the surrounding medium, and this amount must be deducted from the latent heat of vaporisation to get the true cooling effect per lb. of gas. If the latent heat is 562.6, then the cooling effect will be 517.6 B. T. U. per lb.

The weight of gas passed through the machine per hour will be the stroke volume per hour, multiplied by the weight of ammonia gas per cubic foot at the evaporator pressure. The stroke volume will be

$$\frac{7\frac{1}{2}\text{x}7\frac{1}{2}\text{x}.7854\text{x}10\text{x}75\text{x}60}{1728}$$

and this multiplied by .143, the weight of a cubic foot of gas at 42 lb. absolute will give the weight per hour. This again multiplied by the cooling effect per lb. ammonia will give the cooling effect in B. T. U. per hour. This multiplied by 24, the cooling effect per 24 hours, and divided by 140 x 2000 which is a ton of refrigeration will give the amount of work done in refrigerating tons per day.

$$\frac{7\frac{1}{2}\text{x}7\frac{1}{2}\text{x}10\text{x}75\text{x}60\text{x}.143\text{x}517.6\text{x}24}{1728\text{x}140\text{x}2000}$$

This works out at 7.299 tons. Dividing 280,000 by the cooling effect of one pound of ammonia we arrive at the weight of ammonia to be circulated for one ton of refrigeration. That is

$$\frac{280{,}000}{517.6}=540.9 \text{ or } 541 \text{ lbs ammonia}$$

per ton of refrigerating effect.

Lorenz gives as the minimum horse power for 100,000 B. T. U. per hour cooling effect, 4.98. This will be increased by various factors, such as resistance of valves, etc., from 7.5 to 15 H. P. per hour according to this minimum figure is 17,100. This is based on a temperature of 68 degrees in front of the regulation valve. It will be seen that cooling the liquid leaving the condensor to a temperature lower than 68 will increase the cooling effect of the gas as the nearer the temperature of the liquid is to the temperature of the evaporator, the less heat will be given up to the medium surrounding the coils, and the nearer will the cooling effect come to the actual latent heat of the liquid. This calculation also shows that the higher the back pressure, the greater the density of the gas entering the compressor and the greater the weight of gas handled per stroke. The closer the condensor pressure is kept to the evaporator pressure the less work will have to be done by the compressor, and the higher the efficiency of the machine.

LIQUID LOW IN RECEIVER

Question:—I understand that the liquid line in the receiver extends to within four inches of the bottom, and that the liquid should be at all times sufficient to cover the bottom of this pipe. What would be the effect if the liquid got below this point?

Answer:—The effect of the liquid line being uncovered would be to fill the line with gas instead of liquid passing through the evaporator regulating valve, or the expansion valves in a direct expansion system, only gas would be passing through. The immediate effect would be to raise the temperature in the evaporator or in the direct expansion coils, and a loss of cooling effect. It is the extraction of heat by the vaporisation of ammonia liquid into a gas that gives the cooling effect, and if gas instead of liquid is passing the regulating valve, these is no possibility of cooling. It might seem at first glance as though the liquid receiver would become cold, and really act as an evaporator. There would be a certain amount of cooling effect in the receiver under these circumstances, but owing to the relatively small amount of liquid evaporating, this would not be very great. As a matter of fact, in practice, a shortage of liquid can be detected by the fluctuation of the discharge pressure gauge, the sound of the gas passing through the expansion valve. and the general behaviour of the machine.

CARE OF BOILER

Question:—Would you kindly inform me through the columns of your valuable paper, the proper method of caring for a steam boiler after being in use. Also the best condition to leave same when not in use. Also what is the shortest possible time in which to bring a 150 H. P. boiler from cold water to temperature to sufficient heat to generate steam without doing injury to same?

Answer:—In preparing a boiler to go out of commission, the first thing to do is to burn the fires down, so that all the combustible in the coal is consumed and there is nothing left to pull out but the ash. The boiler should be used to supply steam to some auxiliary or heating system until the pressure is all worked off when that is possible. When the pressure is all gone a valve on top of the boiler should be left cracked to prevent the forming of a vacuum in the boiler, and the water should be left in the boiler until the brick work of the setting has cooled down sufficiently to prevent any danger of burning the sheets when the water is emptied. This may take from eight to twelve hours; and during this cooling process the main damper should be open just sufficiently to create a gentle draught through the furnace and setting so that the radiant heat from the brickwork can be carried away. When satisfied that everything is cooled

down sufficiently the top manhole can be knocked in, first making sure that there is a valve open for the admission of air, and no vacuum is formed in the steam space. This can be ascertained by opening the drain at the bottom of the water column, and noting if the water flows freely. If it does it is all right to go ahead, but if not, the top connection to the gauge column, and one of the try cocks may be left open, or the safety valve eased back, or any other method of establishing communication with the atmosphere that presents itself may be used. When knocking in the top manhole door of a boiler that has just been put out of commission, a stout rope should be fastened to one of the manhole door studs, and secured to a handy steam pipe of some fixture, so that when the dogs are taken off, the man doing the work can stand clear of the door, and tap it in with the end of a long bar. The rope will hold it when it swings in, and prevent it from dropping heavily on the top row of tubes, and probably damaging them. If the boiler contains a quantity of hot vapor, which is often the case then the man is well out of harm's way, and stands no chance of being burnt. The manhole door being off, the next thing is to open the blow off pipe, or if fitted with a circulating device, the surface blow off, and let the boiler drain out by gravity. It is a very good plan while this is going on to get the hose rigged, and follow the course of the descending water with a good jet from the hose, washing the loose sediment from the shell and tubes before the heat in the metal has a chance to bake it on. Having got all the water out, the lower manhole or handhole doors may be taken off, and the boiler left standing till cool enough to be entered with some degree of comfort. A thorough examination of the interior of the boiler should be made, and all traces of oil or grease removed, examination made for signs of corrosion, (pitting), and any scale that may have accumulated on shell-heads or tubes removed as far as it is possible to do so. The stays should be tested by tapping with a hammer, and the outlets to the water column examined to make sure they are clear. Externally the brick work should be examined, the nipples where feed and water column connections enter the shell carefully looked at, blow off examined, and the rivet seams looked over for such defects as fire cracks or leakage. After necessary repairs are made the boiler is ready for filling and placing back in commission.

If the boiler is going to be permanently laid up, the following procedure is recommended. Remove all ash and clinker from furnace, and soot, etc., from the back ends. Take a good steel wire brush and remove all the deposit from the tube plates both front and back and also from the shell over the furnace and combustion chamber. Any brick work that may be defective and can form a harbouring place for moisture should be pulled down clear of the metal. If the boiler is going to be in a warm boiler room all the time it is closed down, these precautions should guard against oxidisation or rusting externally. Where there is no danger from freezing the boiler can be filled absolutely full by removing a valve on top of the boiler to exclude all the air, and filling right up, till the water overflows from the valve. A boiler filled in this way will not rust internally. If there is danger of freezing, the boiler should be dried out thoroughly, a panful of unslacked lime placed inside and the manhole and handhole doors put on. The unslacked lime will absorb any moisture that may be present, and thus prevent any corrosion. The presence of damp soot in the combustion space of a boiler that is laid up is a source of very present danger from corrosion, and should be avoided by careful removal of all loose soot before laying up. In the case of a boiler with the stack set right above the smoke box, as is often the case in sawmill boilers, especially those with overhanging fronts, the stack should be effectually closed up, so that snow and rain cannot come down and lie in the smoke box. Summed up, the object should be to avoid any possibility of rusting while the boiler is laid up, and remember that many a good boiler has had its life shortened by many years through neglect of these simple precautions.

Regarding the length of time required to raise steam. It is as well to make this proceeding as leisurely as possible. It is not so much the danger of damaging the boiler, as in the case of a H.R.T. boiler with clean surfaces, the heat transmission and circulation are fairly rapid, but more especially the brick work should be considered. This should have a chance to warm through slowly and evenly, so that the expansion of the outside lining of fire brick and the inner rows of ordinary brick may proceed equally. There are many divergences of opinion in these matters, but with a H.R.T. boiler the writer has always endeavoured to have at least twelve hours to get steam showing. Once you have steam, you can soon bring up the pressure, but the intervening time gives a chance for a moderate fire, very little draught and a gradual absorption of heat by the mass of brick in the setting. As a contrast to this, the writer has seen a Yarrow water tube boiler, with no brick setting, brought from cold to 250 lbs pressure in twenty minutes. Scotch marine boilers, with hydrokineters or circulating arrangement from the donkey feed pump, and no brick work, are usually given from a minimum of twelve hours to a more general rate of eighteen hours, and some men give them twenty-four. On the whole would say take all the time you can get with of course an eye to the amount of coal you are going to use in keeping the boiler standing after steam is raised.

PIPE INSULATION QUESTION

Question—I have noticed in many of the smaller boiler houses copper feed water lines with no insulation. Would it be better to use wrought iron pipe or what would be the difference if the wrought iron pipe is covered?

Answer.—Copper pipe is used in feed lines chiefly on account of its non-corrosive properties. It is also lighter, and allows of being bent into shape to fit restricted positions. As regards covering it should be covered to prevent heat losses. although the relative losses between uncovered copper pipe and uncovered wrought iron pipe would probably be in favor of the copper. While copper is a better conductor of heat than wrought iron, yet wrought iron is a better radiator of heat than copper. Any pipe carrying a fluid at a much higher temperature than the surrounding atmosphere should be covered in the interest of economy.

THE GENERATION OF CRACKS IN BOILER-PLATE

In recent years cases of failure in boiler-plate have occurred which have been attributed to brittleness, although tests made before the plates were prepared for rive ing revealed no weakness of that nature. Moreover, test-pieces taken from defective plates showed, after annealing, no brittleness. Tests of the defective plates revealed in several instances a brittleness in the metal round about the rivet-holes. The authors give numerous examples of such failures. These occurrences have led to much discussion and to searching investigation. The new etching process throws light on these failures, and reveals their probable cause. Any disturbance of structure due to violent treatment of the metal, such as the shock of blows in riveting, the strain of punching, or of a bending movement—or even vibration set up by drilling bolt and rivet-holes—causes a streaky appearance in the metal, which seems to be the beginning of cracks, or at least lines along which an alteration of structure has occurred favorable to fracture. These lines are not made visible by the older processes of etching. Any violent working on the metal when cold will produce these streaks or lines which by the new process of etching, are made visible to the naked eye.

The chief interest of this article lies in the exhibition of the differences of appearance between test-pieces respectively treated by these methods. Plates exhibiting enlarged views of the different effects of the old and the new etching are given. The purpose of the authors was to afford opportunity for this comparative study. The twenty-two illustrations given not only show the effects of the new process, but also suggest the cause of many a failure of material hitherto hidden. Working on the metal in the cold has serious weakening consequences, for which a remedy has to be sought.—B. Strauss and A. Fry ("St. and Eis.")

GREASING DEVICE

A British firm has brought out a device which makes the grease filling on motor cars a simple, clean process, or at least as clean as it possibly can be. The device is fitted to the tin containing the lubricant, and has a screw with a nut which takes the form of a leather-packed piston of the diameter of the tin.

As the handle attached to the device is turned, this piston is forced down upon the grease, which is thus squeezed out of a hole in the bottom of the tin into the base of the device. From this, in turn, it emerges through a spout from which syringes, lubricators, etc., can be filled. In addition to avoiding the soiling of hands, this simple invention has the advantage of keeping the grease free from grit and dust which gathers in tins which have to be frequently opened.

The Operators' Point of View

HOW TO SPLICE STRANDED WIRE

By E. D. HUNT

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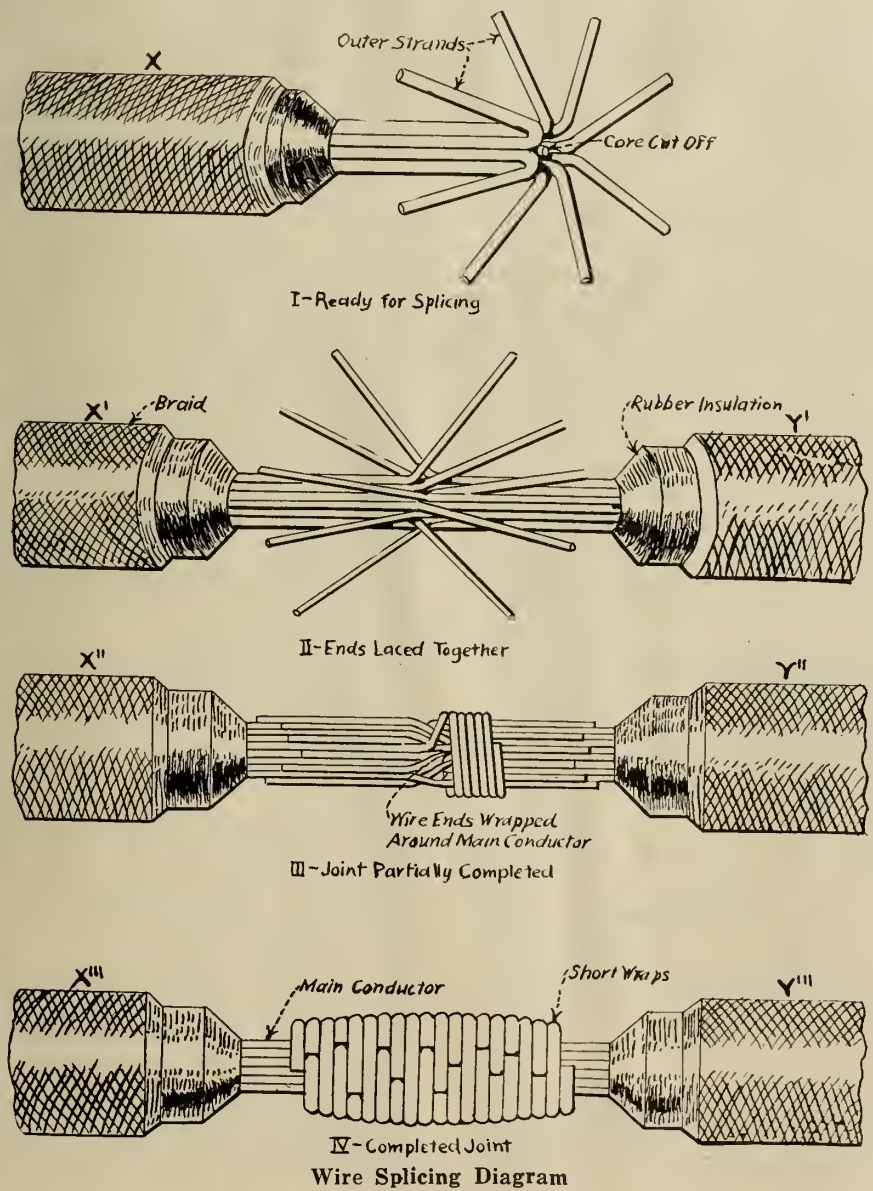
Almost any practical man can make a splice, between the ends of two stranded conductors, which will carry the current safely and satisfactorily but few of them, apparently, know how to make such a splice in minimum time and so that it will have a neat, business-like appearance. The accompanying picture illustrates the steps in the process which, so experience has indicated, it is best to follow. The first step is to "skin" the wire and sandpaper it until it is bright and all the rubber or other insulation has been removed from the conductor. Next the ends of the outer strands should be bent back to expose the core which should then be cut off. The end of the conductor will now appear as shown at I.

Now the outer strands which were bent back, to be out of the way so that the core could be cut off, are forced almost to their normal position. The two ends to be connected are laced together as suggested in 11, where X^1 represents one of the conductors to be spliced and Y^1 the other.

Proceeding, each one of the free ends is twisted around the main conductor, as shown at III. First, a conductor of X^{11} should be made up around the main line and then one of Y^{11}. This process is continued until all of the free ends have been served around the main line. The joint should now appear as shown at IV and is ready for soldering.

To solder it, the molten metal should be poured, with a ladle, so that it will drain into the solder pot through and around the joint until the joint becomes hot enough so that the solder will permeate it and stick to it effectively. After the joint has thus been uniformly heated and appears to be "tinned" over its whole surface a wet piece of waste can be held on it to cool it quickly. Tape servings around the joint, to the thickness of the insulation of the original wire, complete the splice.



Wire Splicing Diagram

INDICATOR CARD CRITICISM

Editor Power House

Dear Sir:

While your suggestion in regard to the card submitted in your issue of the 21st Nov., page 39, is probably correct, would not lost motion in the pencil mechanism show similar defects. Because, in the rapid fall of the expansion line, the lost motion between the mechanism of the pencil and the piston tends to make the pencil lag to isothermal, regaining normal again in the more uniform expansion towards the end of the stroke to release. One cannot criticise this card owing to insufficient data furnished, but taking the % of cutoff in either end and assuming the right side of the card to be the H.E. the % of cutoff is 24.3% while that of the C. E. is 21.6%. Investigating further and assuming a 60 lb. spring used, the M.E.P. of the H.E. works out 28.8 lbs. per sq. while that of the C.E. is 27.2 lb. per sq.

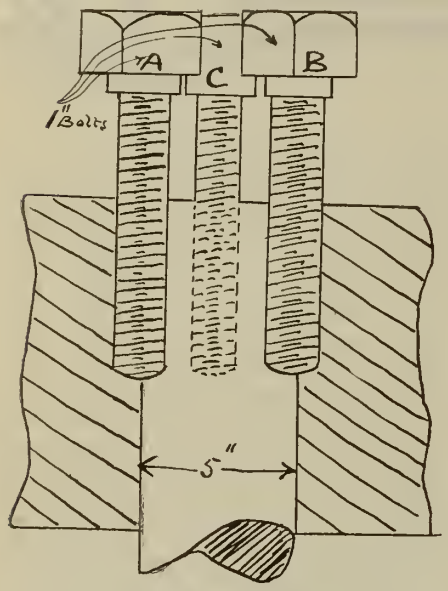
Otherwise the card is a very fair card for the class of engine but in tracing it out the sender might have avoided the mistake shown by drawing the back pressure line where it belongs, and as a suggestion, when a card is submitted as the above, would it not be possible to have it given the actual size and all available data pertaining to it furnished?

Alex. Bennett
Weyburn, Sask.

CRANK PIN REPAIR

By J. M.

A fair repair can be made on a small loose crankpin by drilling and threading three holes around the circumference and screwing in bolts as shown in the sketch at A.B.C. The bolts should be a very tight fit, and saw-



Crank Web Pinned

ed off flush with the disk after being screwed home. The diameter or the number of bolts used should be increased as the diameter of the crank is greater than that shown. With a smaller crank pin 5-8 or 3-4 inch bolts can be used.

AUTOMATIC PIT DRAINER

The sketch shows an automatic drainer easily made by any handy man. It is necessary to have a steam pressure 25 pounds or over. It will work with a high water pressure jet instead of the steam, but the results will be much less satisfactory than the steam and the discharge head will be less with water than with steam at an equal pressure.

It is obvious the outfit can be made as large or as small as desired. When a small size is wanted the tank or pit can be a box or a barrel sunk below the floor level instead of the cement tank shown. The sketch shows the float made from an ordinary 5 gallon can. The screw is removed, by filing, from the gate valve stem A, so that the seat will open and shut with a pull instead of turning the stem. The joints at B and D are rigid, they are pivoted at C and E.

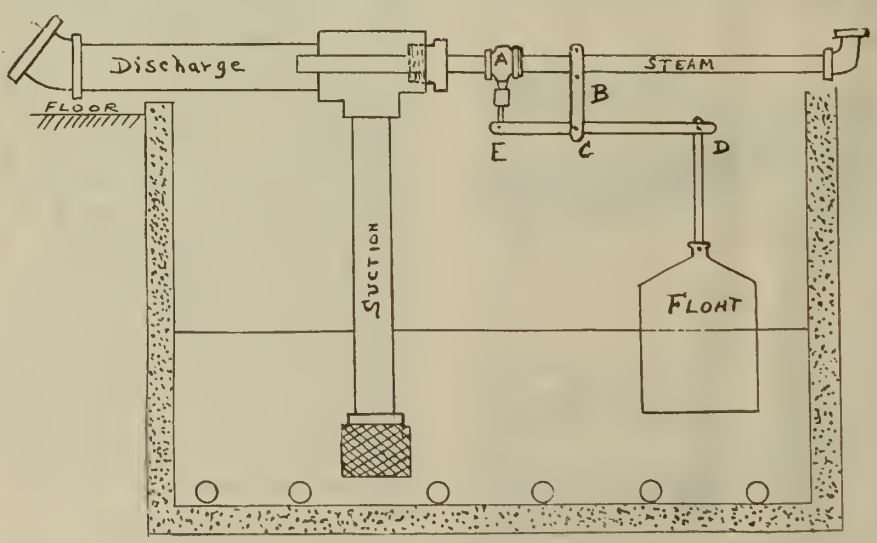
If the water that is to be removed does not flow over the top of the box from the outside, it will be necessary to leave openings in the bottom to allow entry for the water. Holes are shown along the bottom in the drawing. As the water gets to a high level the float also rises and thus opens the steam valve A. As the level of the water lowers the valve is gradually closed.

DOMINION CERTIFICATE AND OTHER THINGS

Editor Power House:

Your write-up on certificate question, in a recent issue, was right to the point and there is not a shadow of a doubt but what our certificate should be Dominion wide. As to renewal of same, this to my way of thinking, and all engineers that I have talked to, is a rank injustice. It places the engineer under a penalty to earn a living while every short while we find someone doing some work and paying nothing and getting away with it too. I believe you have the right idea so more power to your pen. I believe you have the engineers of this province solidly behind you, also, that it is our duty to write and say so. I wish to agree with J. E. Noble in his kick as to Canadian engineers not writing to our engineering journals. The shoe fits, so let's put it on. I see his letters in both Canadian and American journals, and he says some very interesting and helpful things. What have we given him in return? I also wish to thank our Editor for the course he has run in Power House. It has helped me wonderfully. In Nov. 21 issue a correspondent asks if he has sufficient power in his engines to saw 140,000 ft. per day. Yes, he has. One place I was in charge of engine and boiler room, we cut 100,000 to 110,000 feet per ten hour day, with a 400-h.p. engine. He says his engines can be pulled down with bottom saws, if so there is something radically wrong with them or the sawyer, that is if his engine is in good condition and by his cards shown in same issue, I would say distribution is very bad. If he cares to write me personally I will help him all I can. Wishing P. H. and its editors and readers compliments of the season.

W. H. Long,
Monteith, Ont.



A Longitudinal Section of Pit

LOW TEMPERATURE RETORTS

The chief requirement to be complied with in the design of retorts for low-temperature work is adequate provision for temperature contro.. The carbonization must be carried out in such a manner that neither the coal nor the vapor distilling from it is subjected to a temperature in excess of 750 deg. C., since otherwise there will be decomposition of the primary tar oils and their quality will be vitiated. Further, and herein lies the chief difficulty with which the engineer must contend, the coal must be uniformly heated and to a high enough temperature, within the range specified, to complete its carbonization. The engineer is thus restricted to the use of low-temperature gradients, and at the same time he must force heat through the poorly conducting charge with sufficient rapidity to obtain a reasonable output of products.

It will be seen that the heating problem differs greatly from that of heating high-temperature retorts. Here the temperature of the retorts, settings may be made as high as is consistent with reasonable life of refractories and economy of heating gas. High temperatures are of course conducive to rapid operation.

In the writer's opinion there is some advantage to be gained in designs based on distillation under reduced pressure provided they are not too expensive and do not lead to excessive operation costs. The same may be said of those which involve recirculation of the distillation gases. In both devices the main purpose is to remove the distillation vapors from the retorts as rapidly as they are formed and thus prevent thermal decomposition. In some recirculation devices the gas is made to give up sensible heat to the charge; all or at least a part of the heat required for carbonization is supplied in this way. The idea involved here is theoretically sound since it provides a means of getting around the difficulty of low heat conductivity of the charge and at the same time promotes uniformity of heating. The chief difficulty in applying this idea is that of economically supplying the gas with the required amount of heat, owing to its low heat capacity. Further, charges through which gases are circulated must be stirred for most efficient results and stirring precludes the formation of a well coked residue.

Toronto C.A.S.E. No. 1

HIS LODGE is keeping up the activity with which it started out at the beginning of the year. At the last meeting, which was very well attended, an interesting report from the auditors was presented, which showed a healthy state of the finances of the organization. After several members had been initiated, the educational committee went on with their work. This part of the C. A. S. E. activities is assuming more and more importance, and is being very much stimulated by means of an interesting competition which is being staged under the auspices of the Grand Lodge. A prize is being presented by the Dominion Flow Meter Co., consisting of a portable Gebhardt Steam Meter. The competition consists of a series of questions which must be answered on the floor of the Lodge, without any assistance from text books or references, and the answers contributed by the different members of the Lodge are sifted out and the best ones adopted as the answers of the Lodge collectively. The prize will go to the Lodge which gives the best answers to all the questions in the judgment of an independent examiner. We publish here a set of questions and answers which are typical of this competition. It will be easily seen what a lot of value this kind of competition will be to the members of the organization.

The movement to the new meeting hall has been a pronounced success, both from the point of view of the members' accommodation, and the added attractions for those not members but wishing to become so. A good deal of demonstrating work on the blackboard is done by the educational committee, and the members themselves, and the more questions that are brought up the better for everybody concerned.

Following is a list of the questions and answers submitted at the last meeting in connection with the competition.

Competitive Questions and Answers

Question No. 1—Give a description of three types of feed-water heaters:

(a) Open type—water either sprayed or spilling and falling and thereby coming in contact with either live or exhaust steam and thereby equalizing temperatures, at or about atmospheric pressure.

(b) Closed type—in which case the water and steam are equalized at pressures above atmospheric.

(c) Combined or indirect type in which case either or both the water and steam may be introduced above atmospheric pressure, but the equalization of temperature takes place via or through a metallic medium (shell or tubes) and the condensation in this case is usually lost because of its containing either oil or some other deleterious substance.

Note. An adaptation covering this latter scheme is often provided by taking an old H. T. B. and fitting it up with extra enclosed ends and passing the exhaust steam through the tubes and the water to be heated passing in and out of the boiler in the usual way (feed and B. O. pipe.)

Question No. 2 (a) What are the chief advantages of the use of condensed steam for boiler feed purposes?

Answer No. 2 (a) Saving in fuel and reduction of the quantity of boiler compound required if not eliminating its use entirely, as most of the impurities are removed which tend to form scale; also the saving of the heat units which would otherwise be lost.

Question No. 2 (b) What are the disadvantages, if any?

Answer No. 2 (b) Danger of oil from exhaust steam when trap or oil separator is in operation; also danger of pitting in some cases.

Question No. 3 (a) Give description of three kinds of water softeners, stating advantages of each.

Answer No. 3 (a) (1) Setting tanks for treated water (2) Soda and Lime mixing and settling tanks, (3) Permutit and other systems with combined filters.

Note. Chemicals used for treating feed water, besides those of lime and soda consist of caustic soda and various colloidal substances.

The advantages of each are as follows:—

3-a (1) Settling tanks where water contains coarse matter which is suspended but not in solution.

3-a (2) Soda and lime treatment where there is combined hardness and suspended matter.

3-a (3) Permutit system or zeolite where only hardness is to be dealt with.

Question No. 3 (b) Name some of the substances that commonly exist as impurities in feed water.

Answer No. 3 (b) Vegetable and organic matter, lime, carbonates, and sulphates of calcium and magnesium, acids and various corrosives.

Question No. 4—Give description, and point out the difference between an open (a) and a closed (b) feed-water heater, giving reasons for installation of either type.

Answer No. 4 (a) Open feed-water heaters consist of either perforated plates or trays in which case the water in falling or splashing comes into contact with the exhaust steam and equalizes in temperature also condensing the steam into water which settles in the bottom and in passing out passes through a bed of coke or other filtering material.

Answer No. 4 (b) Closed feed-water heaters:—In this type the water is circulated either inside of coils or a chamber outside of and with which the exhaust steam comes in contact and equalizes in temperature, but the product of condensation is generally lost because of the presence of excess oil or other deleterious matter, as above stated.

Question No. 5—State various boiler-feeding appliances in the order of their economy?

Answer No. 5 (1) High-pressure steam direct return traps.

(2) High-pressure steam feed-pumps.

(3) Various types of steam injectors.

(4) Indirect gravity return traps (over boilers).

Question No. 6—How may boiler feed-water be purified by live steam; and is there any apparatus in the market for this purpose? If so, describe it and cite advantages possessed.

Answer No. 6—There are several makes of feed-water purifiers on the ...pes, Webster and Dakin; however most modern feed-water heaters have the combined effect of heater and purifier.

Question No. 7—Why should advantage be taken of all sources of waste heat to increase the temperature of the feed-water heater?

Answer No. 7—Direct economy by raising the temperature of F. W., and indirect saving by preventing scale and resulting leaks and maintenance expense.

Question No. 8—What is so-called Fuel Economizer? Give sketch and description.

Answer No. 8 (1) Any device or contrivance by means of which direct economy in the use of fuel (or burning of) is effected may be said to be a fuel economizer;

(2) However the fuel economizers which are generally well known are the Greene and the Sturtevant.

(3) They consist of cast iron vertical tubes and cast iron horizontal headers.

(4) The results accomplished are indirect or secondary so far as fuel economy is concerned, comprising the absorption of what might otherwise be waste heat or excess heat in the flue gases and the results depend largely upon the varying points at which combustion takes place in a boiler or furnace.

These so-called Fuel Economizers would be better known as Auxiliary Feed Water Heaters and Economizers. They are equipped with Safety Valves, blow-out and clean out openings and generally conform to all the requirements of a Closed type of feed water heater.

Question No. 9—What are the principal sources of waste heat in connection with a steam Power Plant?

Answer No. (1) Uncovered or bare steam and hot water pipes.

No. (2) Leaks in Boiler B. O. or safety valves; also leaks in valves, traps and uncovered heaters.

(3) Tops of boilers or steam drums, and furnace walls not covered or badly insulated, cracks in brickwork, or smoke flues, reducing flue gas temperature;

also excess flue gas temperature in breeching or stack.

(4) Scale or mud deposit on heating surface or excess suspended matter entering the circulation within boiler.

(5) Loss condensation (hot water).

(6) Unexpanded exhaust or excess live steam discharged direct to atmosphere, because not required for hot water heating and no provision made for storage of excess hot water or condensate.

Question No. 10—What area of tube surface should be provided in a (closed type) feed-water heater for a 250 H. P. engine, if the steam is supplied at a temperature of 215 degrees F. and the feed water heated from 65 to 190 degrees?

Note. In calculating state of what metal the tubes are made and why not of steel or iron?

Answer No. 10—About 1 sq. ft. of tube or heating surface for each 3 H. P. of engine capacity and the tubes are best made of copper because:—1st, Copper is a better conductor of heat than either iron or steel.(2nd) Because it resists the pitting and corrosive effects of some boiler compounds better than either iron or steel.

Example: 250 divided by 3 equals 83 sq. ft. or area of heater surface required.

INVESTIGATION ON WASHING COAL

The investigation of bituminous coal washing practice in the Middle Western States, being conducted by the United States Bureau of Mines, the mining department of the University of Illinois, and the Illinois Geological Survey in co-operation, has been extended by a survey of methods in use in Alabama. The object of the work is to conserve coal resources by minimizing coal losses and to increase the utilization of Middle Western coals for coking and other purposes by reducing the sulphur and ash content. A number of coals have been examined in the field and at the laboratory in order to determine the practicability of washing them. Coals from Clay County, Ind., and from Columbiana County, Ohio, have been washed successfully. Particular attention has been paid to the cleaning of coal on concentrating tables, and to a determination of the factors that affect the washability of coal.

For the purpose of aiding the industry in securing washing plants adapted to cleaning a particular coal, data have been collected for a bulletin describing methods to be used in the examination of a coal to determine the general type of washery required.

As bearing on the difficult problem of the treatment of fine coal—a problem confronting many washery operators—a comprehensive series of tests on the dewatering of washed-coal sludge with vacuum filters has been completed and will be published.

As about one-fourth of the bituminous coal produced in the United States is used in industrial power plants, the waste of unburned coal and coke in the ashes from boiler plants has been investigated. It is possible to recover the greater part of the unburned fuel at a profit by washing the ashes on a concentrating table. A report of this work has been published as a report of the Bureau of Mines.

The investigation of the occurrence and distribution of the forms of sulphur in coal is being continued. This work is considered essential because of the depletion of reserves of low-sulphur coal, and it is being conducted with the object of rendering high-sulphur coals more suitable for metallurgical uses. Sulphur reductions obtainable by cleaning a coal depend entirely on the physical and chemical forms of the sulphur in the coal. Sulphur occurring in organic combination with the coal substance and finely disseminated pyritic sulphur cannot be removed by washing. Methods have been developed for determining the fine pyritic sulphur.

The distribution of the sulphur forms in the coal bed itself have been determined in two beds in Kentucky, one in Illinois, and one in Alabama. Organic sulphur constitutes a larger proportion of the total sulphur in coal than is generally recognized. Of 110 face samples taken in four beds, in 53 samples the organic sulphur made up more than 50 per cent. of the total sulphur. The results so far obtained have been published as Co-operative Bulletin No. 124 by the engineering experiment station of the University of Illinois.

A study of the coal-washing problems in the State of Washington is being conducted by the Bureau of Mines at the Northwest Experiment Station at Seattle, in Co-operation with the University of Washington. A special study of similar problems in the State of Oregon has been made in co-operation with the Oregon Bureau of Mines and Geology.

Representative samples of run-of-mine coal from a number of mines were tested by screening, the float-and-sink method, and laboratory washing equipment, to determine the distribution of ash impurities from the clean coal by washing, and the degree to which the quality of the coal may be improved. At the same mines samples of all washery products were tested by the float-and-sink method to determine the effectiveness of the washers as co-operating, and possible improvement of their effectiveness by the float-and-sink method of control. Many supplementary laboratory tests were made with an experimental jig and coal-washing table to determine the possibility of improving the quality of the washed coal and decreasing the loss of good coal in the washery refuse, by the use of improved coal-washing methods and equipment.

In co-operation with the mining companies the coal washeries at Issaquah, Grand Ridge, Ravensdale, and Wilkeson, in the State of Washington, and at Beaver Hill, Oreg., have been studied. All experimental work, except the supplementary laboratory tests, was done in the plants.

The principal results of the tests show: (1) The raw coal as it comes to the surface contains much bone, shale, and clay, most of which must be removed before the coal is marketable; (2) the present washeries are inefficient, the washed coal containing avoidable impurities, and the refuse containing an excessive proportion of good coal. Proper adjustment of the washers not only improved the quality of the washed coal but also greatly reduced the loss of good coal in the refuse; (3) by re-arranging present flow sheets and replacing many old machines now in use with improved coal-washing equipment, the practice at each plant could be greatly improved.

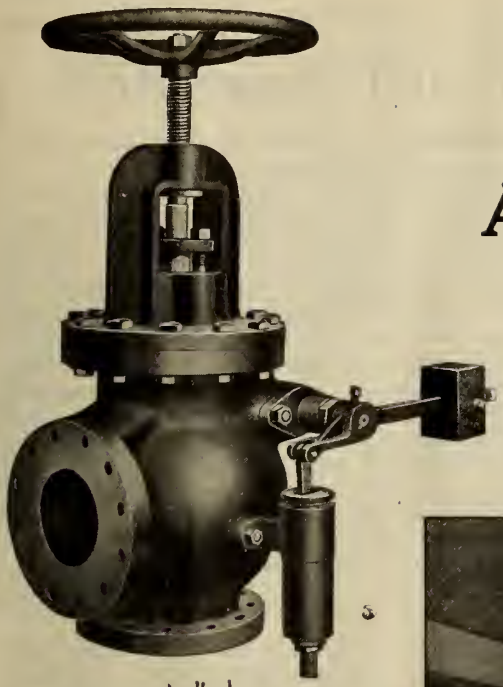
Since the completion of these studies, two coal companies have re-modeled their plants and another company has started work on a new plant to replace its present one. Based largely on results of experiments by the Bureau of Mines, one mine is building a table-washing plant to treat a pile of refuse amounting to more than 1,000,000 tons, estimated to contain approximately 200,000 tons of recoverable coal of coking quality.

Two papers are being prepared for publication by the Bureau of Mines, one on the subject of "Specific gravity studies of Washington coals and their associated impurities," and the other on "Study of coal-washing problems in the Northwest."

Tests of the froth-flotation process, now widely used in concentrating various ores, showed that clean coal can be separated from ash in material passing a 20-mesh sieve or finer. A great many coals, however, contain bone, or bony coal, in which the carbonaceous matter is so intimately mixed with ash that 200-mesh grinding does not separate them. As the bony coal is not as easily floated as the clean coal, retreating the froth concentrate of coal yields clean coal, the bone forming a "middling." By the use of this method 95 to 98 per cent. of the carbonaceous matter in the coal can be recovered in the concentrate and middling, and from 30 to 70 per cent. of the ash discarded as tailing.

Whiting Corporation, Harvey, Ill., (Chicago Suburb) has purchased a controlling interest in the Grindle Fuel Equipment Co., manufacturers of complete Powdered Coal Plants for use in connection with malleable furnaces, annealing ovens, steam boilers, billet heating and various other types of furnaces.

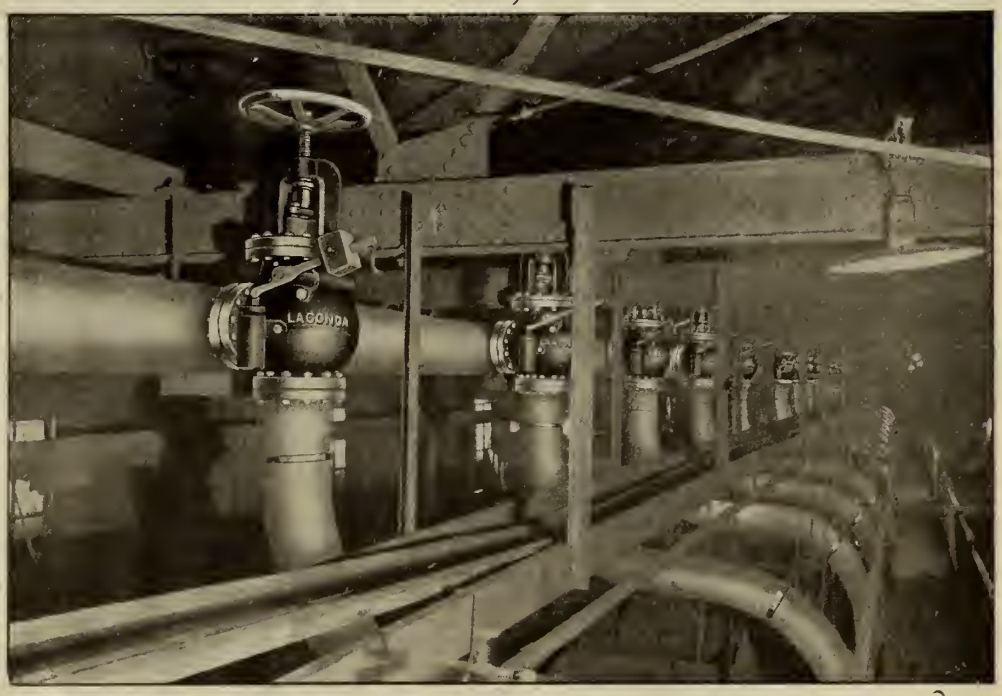
The Grindle Fuel Equipment Co. has moved its offices to Harvey, Ill., and will continue its business under the same name, Whiting Corporation, and will manufacture all Grindle equipment.



LAGONDA

Automatic Cut-off Valves

--Safeguards of the Boiler Room



Typical installation of Lagonda cut-off valve

Power Plant Equipment—
"B & W" Boilers and Superheaters
"LAGONDA" Reseating Machines
Boiler-tube Cleaners, etc.

LAGONDA AUTOMATIC CUT-OFF VALVES are essentially safety valves, protecting life and property in the boiler room. They are designed to close automatically in case of an abnormal flow of steam in either direction through the valve. They are doubly automatic and work in either direction. So serviceable have they proved under all classes of work that from Alaska to Asia the demand is *"Lagonda Valves."*

In the power house and industrial plant *Lagonda Valves* have few equals for all-round utility. In case of a tube rupture or boiler accident they at once isolate the injured boiler and prevent the other boilers connected to header from emptying through the rupture. They check live steam from entering cold boilers, prevent "lagging," automatically cut boilers in and out of service, etc.

Besides the Class "A" (external dash pot) type shown *Lagonda Valves* are made in many styles for installations in all positions.

Catalogue S-2 gives full details of all Lagonda Valves. A copy of this or data on our other lines sent free on request.

BABCOCK & WILCOX, LIMITED

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, BANK OF HAMILTON BUILDING

What Will Steam Locomotive of Future Be?*

THE GREATEST single item of a railway company's costs are those connected with the running of its locomotives. In the past, railway travel has developed along the lines of higher speeds and more luxurious accommodation, both of which have necessitated the building of more powerful locomotives, meaning in turn a greater fuel consumption and increased running expenses. There is no indication that the future holds anything different in store; in fact, with growing competition from other methods of travel, railways may have to offer still greater facilities than they have in the past. Mr. H. A. Ivatt once remarked that when an engine was built big enough to pull a street of houses—or words to that effect—the traffic department always wanted to couple up the schools as well. Perhaps a hotel will be now required in addition. Who knows?

Compounds And Simples

Speaking generally, continues "The Engineer," who thus speaks on the steam locomotive of the future, the locomotive, unlike other steam engines, has resisted all the efforts of those who have sought to change it from simple to compound expansion. In making this statement we do not overlook the various compounds working on the continent of Europe and in the United States, but compared with all the locomotives in the world, they form but a very small part.

The efforts of such eminent engineers as Webb and Worsdell in this country, Vauclain and Cole in America, and De Glehn and others in Europe, are still fresh in our memory, and it almost seemed at one time that through their ingenuity the compound system was in a fair way to be practically established as a real means of reducing locomotive operating costs through economies in the use of fuel and water. Indeed, there is little doubt that under certain conditions compound engines did effect some economy in fuel consumption; but certain inherent characteristics mitigated against their general adoption, the chief of which was the falling off in economy as the working speeds became higher. Under the same condition the economy of the simple engine improved, and against that fact the compound was unable to contend.

At St. Louis several different locomotives were tried on the testing plant. Amongst them were four different compounds, each having four cylinders variously arranged. Throughout the range of the tests these engines showed an economy in steam consumption per unit of power developed when compared with simple engines. The performance of the De Glehn compound, as against that of a simple Pennsylvania "Atlantic," tested at Altoona, may be particularly noted. The compound consumed at a piston speed of about 500 ft. per minute 20 lb. of steam, against 28 lb. used by the simple; but at 1100 ft. the consumption of the compound had risen to 23 lb., as against somewhat less than 24 lb., used by the simple. The Vauclain and Cole compounds, whilst they both seem to have given generally better results than the De Glehn engine, showed by their curves of water consumption the same characteristics as the De Glehn engine, a point of more than usual interest, for the French engine had four sets of valve gear enabling independent adjustment of cut-off, and the American engines were not so fitted. Of the Vauclain and Cole compounds, the former gave the best results at the higher speeds, its water rate varying from 20 lb. to 21.5 lb. at piston speeds of 650 ft. to 1250 ft. per minute, the latter figure showing an economy of 10 per cent. over the results given by the simple "Atlantic" at the same speed, while at 650 ft. per minute the simple engine required 24 per cent. more water than the compound.

The "Hanover" engine tried had, in addition to compound cylinders the important advantage of a superheater furnishing "low degree" superheated steam. The curve of steam consumption for this engine was, in character, almost exactly similar to that of the "Cole" locomotive, but at 500 ft. per minute, the speed at which it showed the least water rate, the consumption was 17.5 lb., and at 1100 ft. this figure was increased to 19 lb. At the same speed the simple engine using saturated steam showed that it required just less than 24 lb. of water per indicated horse-power.

Superheating

Since the introduction of the arch in the locomotive fire-box, no single improvement has, speaking generally, had such marked effects on the working of the locomotive from its economical aspect as the introduction of the superheater. Superheated steam has made the simple engine more economical almost throughout its entire range of ordinary working speeds than any compound experimented with on the St. Louis plant. Comparing the water rate of the superheated "Hanover" compound with that obtained with the latest type of Pennsylvania "Pacific" type locomotive using superheated steam, the results show that at a piston speed of 800 ft. per minute the water rate for the simple engine was 17.9 lb., that of the compound practically the same, about 17.7 lb., whilst at 1200 ft., 62 miles per hour, with 80 in. drivers, and 28 in. piston stroke, the water consumption of the simple engine was but 16.2 lb. against 19 lb. used by the superheated compound at 1150 ft. per minute, the highest speed at which that engine was tried. At higher speeds of 1400 ft. and 1600 ft. per minute, the simple engine gave 1 indicated horse-power for a water consumption of 15.6 lb. and 15.1 lb.

Enough has been said to show that compound engines, even if supplied with high degree superheated steam, will have to show a considerable improvement in water consumption amounting to at least 15 per cent. at the higher rates of speed before they can compete with superheated simple locomotives in express passenger service.

Superheated Compounds

From the fact that the water rate curves of both saturated and superheated compounds are generally alike in form, each displaying a similar increase in consumption with increase in speed, we gather that there is still room for improvement in the design and proportioning of compound locomotives, so far as the cylinder arrangement is concerned. Will the present pressing needs for economical working prompt designers to attempt again a solution of this interesting problem? We have on occasion seen it asserted that the express locomotive of the future will be a superheated compound, but considering the really wonderful results obtained with modern simple engines using highly superheated steam, we confess that at present we see no evidence of the re-introduction of the compound system into the practical politics of express locomotive design.

The Compounds on Goods Trains

So far we have dealt with express locomotives only. What is the position of the goods engine? Can we expect any economic advantage from the application of a superheater, and with it compound cylinders? In the United States practically all freight traffic is handled by simple engines equipped, of course, with superheaters. For very heavy "pusher" or assisting services, however, four-cylinder compound "Mallet" engines are the rule. These engines by the nature of their work operate at very low speeds, and thus appear suitable for compound working. As a result, some remarkably low steam consumption figures have been attained, and, as we write, we have before us the published results of trials made with a large compound "Mallet" built for service on the Norfolk and Western in 1918. This locomotive at 8.16 miles per hour gave an indicated horse-power for 15.21 lb. of steam; at 10.5 miles per hour, 19.4 lb.; and at 12 miles per hour, 21.2 lb. were required. These speeds correspond to piston speeds of 260 ft., 320 ft. and 385 ft. per minute.

*From Engineering.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	
1¾-in.	29 75	
2 -in.	29 25	19 00
2½-in.	44 75	22 50
3 -in.	49 25	27 50
3¼-in.	.....	34 00
3½-in.	63 50	30 50
4 -in.	85 00	40 00

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$4 25	$3 90
Plates, ¼-in. up	3 75	3 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.99	20.13	19.90	24.04
1½	19.19	24.06	23.79	28.74
2	25.72	20.13	32.01	38.67
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ....base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double.	30-15%
Standard	15 to 40%
Cpt leather lacing, No. 1	2 00
Leather in side	1.80

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	17	Atlas	19
Peerless	22	X Empire	14
XX Grand	16	Ideal	18
Superior	21½	X Press	13
X L C R	15		

Colored

Lion	12½	Popular	10
Standard	11	Keen	9
No. 1	14	Fancy	14

Wool Packing

Arrow	30	Anvil	20
Axle	25		

Washed Wipers

Select white	20	Dark colored	13
Mixed colored	14		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Toronto
Tin	34 00	$39 00
Spelter	7 25	7 50
Lead	6 50	7 50
Antimony	7 25	8 25
Aluminum	28 00	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

POWER HOUSE BUYERS' DIRECTOR Y

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
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MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
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AIR METERS
Bailey Meter Co.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
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Can. Fairbanks-Morse Co., Ltd., Montreal.
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AMMONIA CONTROLLED WATER REGULATORS
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

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Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
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Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

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Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamieson Cold Storage Door Co., Hagerstown Md

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co., Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

BALATA BELTING
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Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
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W. R. Sexton Co., Toronto.

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D. K. MacLaren, Ltd., Montreal, Que.

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BELTING LINK
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BELTING, LEATHER
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Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

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Mackinnon Steel Co., Ltd., Sherbrooke, Q.
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The Mason Regulator & Eng. Co., Ltd., Montreal.
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Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
C. B. Turner, Toronto.

BOILERS
Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal
C. B. Turner, Toronto.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
C. B. Turner, Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Philip Gies Foundry, Kitchener, Ont.
Sexton Boiler Setting Co., W. R., Toronto

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER LINING, PLASTIC
C. B. Turner, Toronto.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

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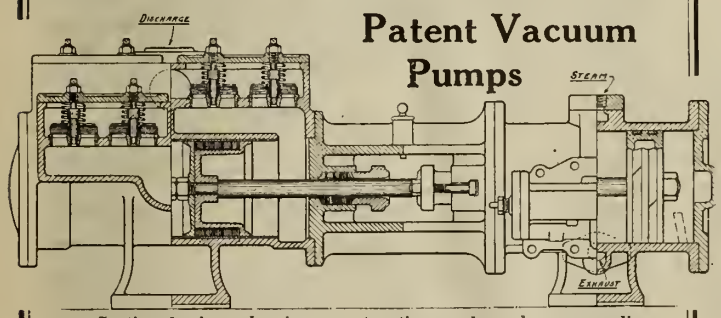

Sectional view showing construction and modus operandi.

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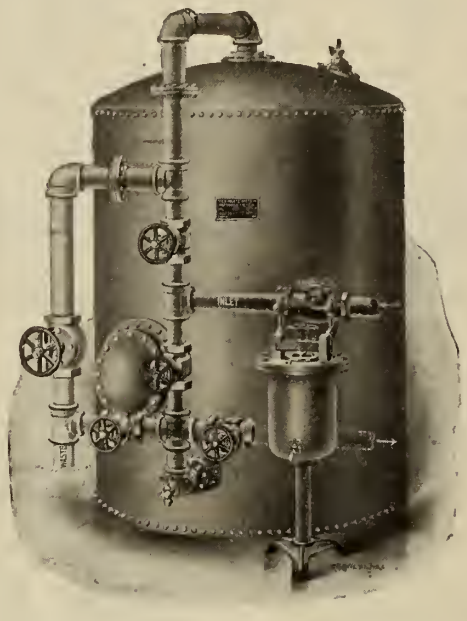

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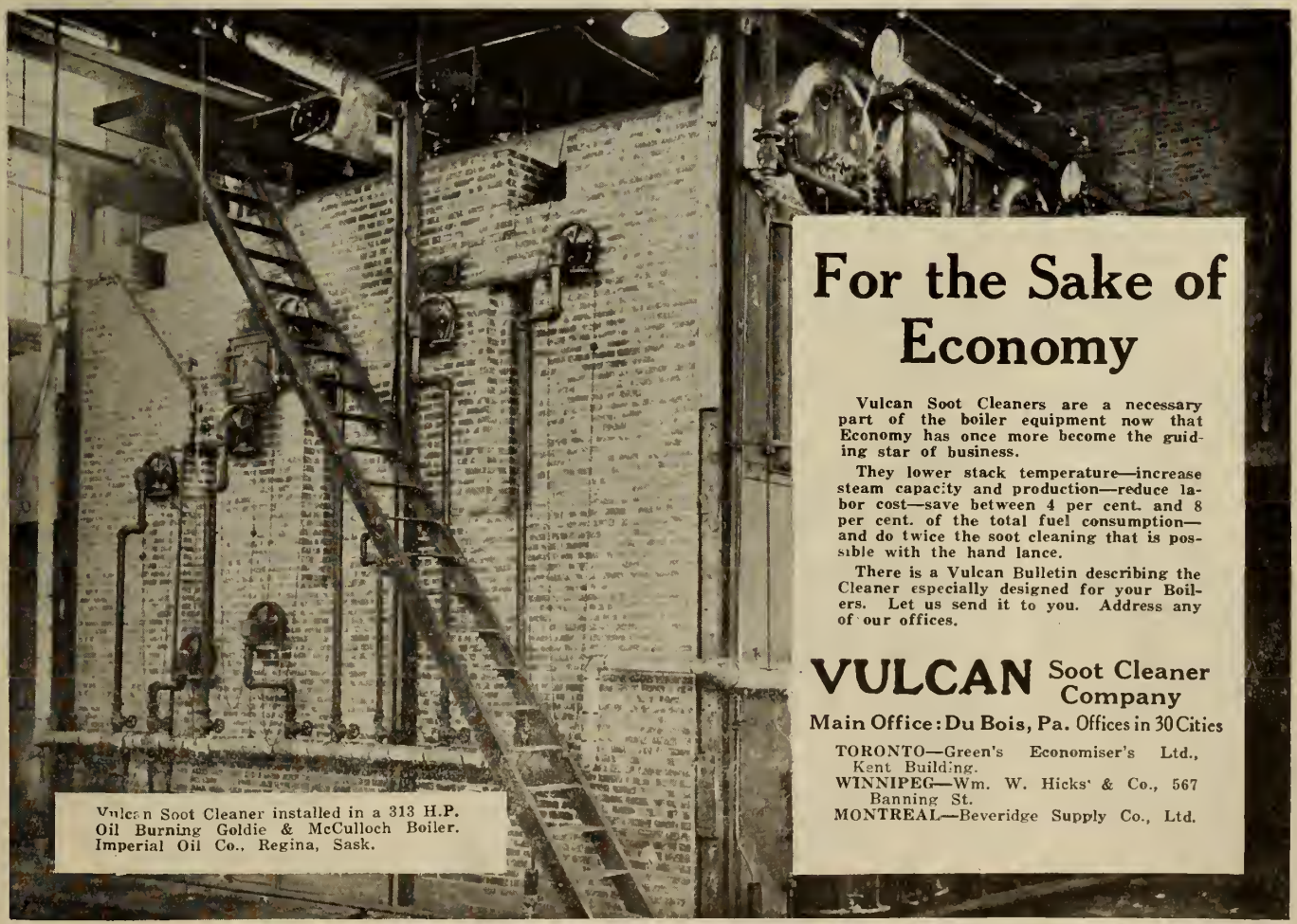

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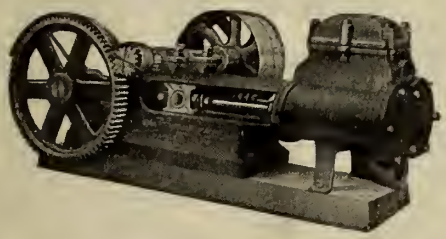

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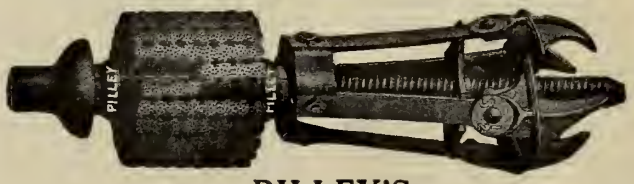

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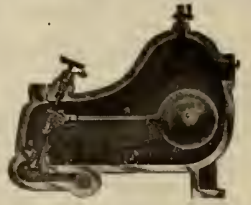

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Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady Co., Hartford, Conn.

VALVES, VACUUM REGULATING
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Lunkenheimer Co., Cincinnati, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Hartford, Conn.

VALVE DISCS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Hartford, Conn.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
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Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa

WATER PAINT
Beveridge Supply Co., Montreal

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WASTE
R. C. Miller Oil & Supply Co., Ltd., Montreal

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WIPERS
R. C. Miller Oil & Supply Co., Ltd., Montreal

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

Bright Spots In The Industrial Outlook

No. 6

"YOU can!—If you think you can," is a saying, the truth of which has been verified in the many instances we have given of business men who in spite of all difficulties in the present year have increased the volume of their trade. What these men have done others can do. You will sit still in vain and wait for "good times" to return. They will never return till you go and fetch them—till you do what the men of whom we have told you have done. Each man must make his own "good times." In addition to the following further instances of "Bright Spots," we are this week giving a buyer's experience which illustrates the way not to do business.

F. W. Staples, Ford Dealer, of Ingersoll, Ont., has been busy recording the best year in his business history. By sheer hard work he has sold over 80 new cars, 12 trucks, 14 tractors, 11 tractor plows, 4 sets of tractor discs and many thousand dollars' worth of accessories, to say nothing of repairs and used car sales. He enlarged his premises and added to his equipment. His 1921 business shows an increase of about 33 per cent. over that of 1920.

The Fuller Brush Co., Toronto. This company was exporting to Canada in 1920 and sales amounted to $5,000 a month. In 1921 they commenced to manufacture in Canada and sales are now $80,000 a month, and 250 salesmen are employed. The company accounts for its rapid increase in business as follows:

(1) Additional advertising — three times as strong as last year.

(2) Better type of salesman due to unemployment.

(3) People will still buy if you have value and can show it.

The organization has been tightened up in every way and selling has been made more and more intensive.

The Interwoven Stocking Co., of New Brunswick, N.J., has been so snowed under with orders that it has been obliged to confine itself to taking care of its old customers and for some time its salesmen have been instructed not to open any new accounts. During the first six months of the year more socks were sold than during the first half of any previous year in the history of the business.

John Wyckoff Mettler, president of the company, ascribes this chiefly to their bold stroke at the end of last year of practically cutting prices in half. "We figured," he explained, "that if a dog's tail has to be cut off you can't save hurting the dog by cutting it off little by little. We knew that by April we would have to have our prices cut practically in half. We decided to make the full cut at once.

"Then just as soon as we saw which way the tide was going we jumped in with an advertising campaign in newspapers in more than twenty-five cities and a series of page advertisements in color in a national medium. We invested a lot of money refreshing the public's and the dealer's picture of Interwoven. We concentrated all our forces. Now we are getting the benefit."

A STRIKING CONTRAST

Now for an experience of an opposite kind: H. W. Acason, president of Acason Motor Truck Company, wanted to buy a car. Read his account of his experiences:

Experience No. 1

"I visited one of the largest buildings in Detroit," he says, "and was quite enthused over a coupe, exhibited on a wonderful floor in a magnificent show-room, talked for half an hour with a well-dressed salesman, told him I was interested, came back the same evening with my wife, both looked at the car and both liked it. We asked to be allowed to ride in it and the salesman promised to drive the car over to our home which was about ten blocks away, and give us a demonstration. This was about three weeks ago, and I have heard nothing further from this salesman and I haven't been offered a demonstration.

Experience No. 2

"I answered an advertisement for a used coupe, went to see it twice and liked it, took my wife with me the third time and drove the car, giving the salesman my business card and telephone number. This was some time ago, and this same car is still being advertised in the papers, and I haven't even been followed up by telephone.

Experience No. 3

"I made two calls about ten days ago at one of the largest retail automobile salesrooms in Detroit and saw two different salesmen and neither one of them knew the retail price of the cars which they had for sale and each one had to go and get a book and look up the price before quoting me. Both these salesmen have my name and address but I haven't heard from them at all.

Experience No. 4

"I saw a used coupe which I thought suited me and went to the salesroom to see it and the salesman didn't even know that they had such a car for sale, let alone knowing where it was or showing it to me.

"In view of business conditions at the present time, it is hardly believable that such experiences as above mentioned can be true, but they are the facts of my own experiences, and I imagine that there are hundreds of other people who could tell the same story."

You can send your sales message throughout Canada from Coast to Coast by means of the following MacLean publications, all of which are members of the Audit Bureau of Circulations. Information regarding circulation, advertising rates and fields covered will be furnished on application.

The MacLean Publishing Co., Ltd., 143-153 University Ave., Toronto

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Dry Goods Review
Men's Wear Review
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Canadian Foundryman
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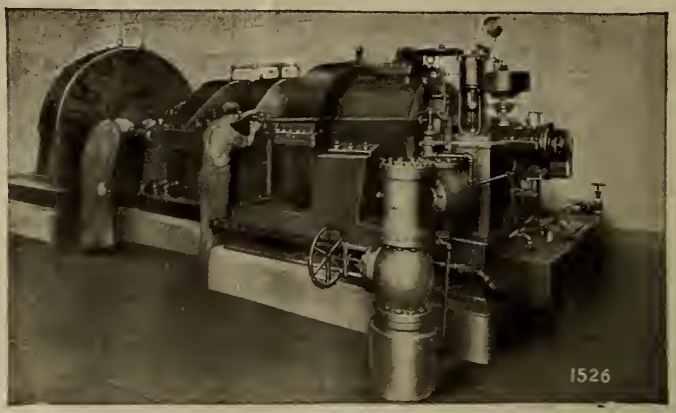
Marine Engineering
Printer and Publisher
Sanitary Engineer
MacLean's Magazine
Farmers' Magazine
Canadian Motor and Implement Trade Journal

Power *For* Auxiliaries



THIS 1500-KW., De Laval geared turbo generator supplies direct current for the operation of auxiliaries in the Delray Plant of the Detroit Edison Company. The turbines operate on steam at 225 lbs. pressure and 210 deg. F. superheat. The steam is exhausted into a varying vacuum of from 24″ to atmospheric exhaust. The condenser is a barometric condenser and the circulating water used is the condensate from the main generating units.

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In such service high efficiency and reliability are paramount. Every De Laval unit is guaranteed as to efficiency and is thoroughly tested at our works before shipment. Our engineers have had extensive experience in adapting the steam turbine to increase plant efficiency and would take pleasure in applying their information and skill to your conditions.

Ask for special catalog A 100.

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TAYLOR ENGINEERING CO., LTD.
Vancouver

De Laval

Steam Turbine Co.

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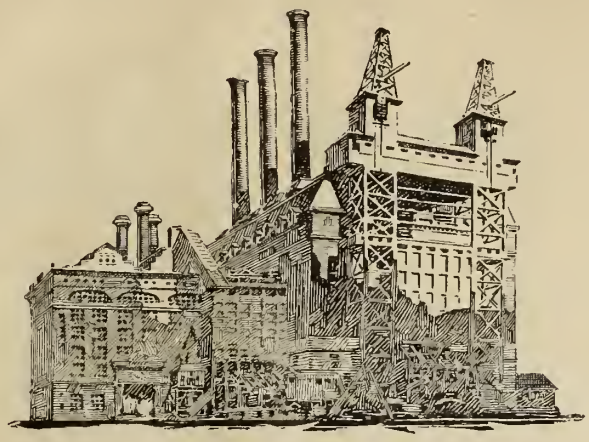

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